Mines and Methods

IN THIS ISSUE

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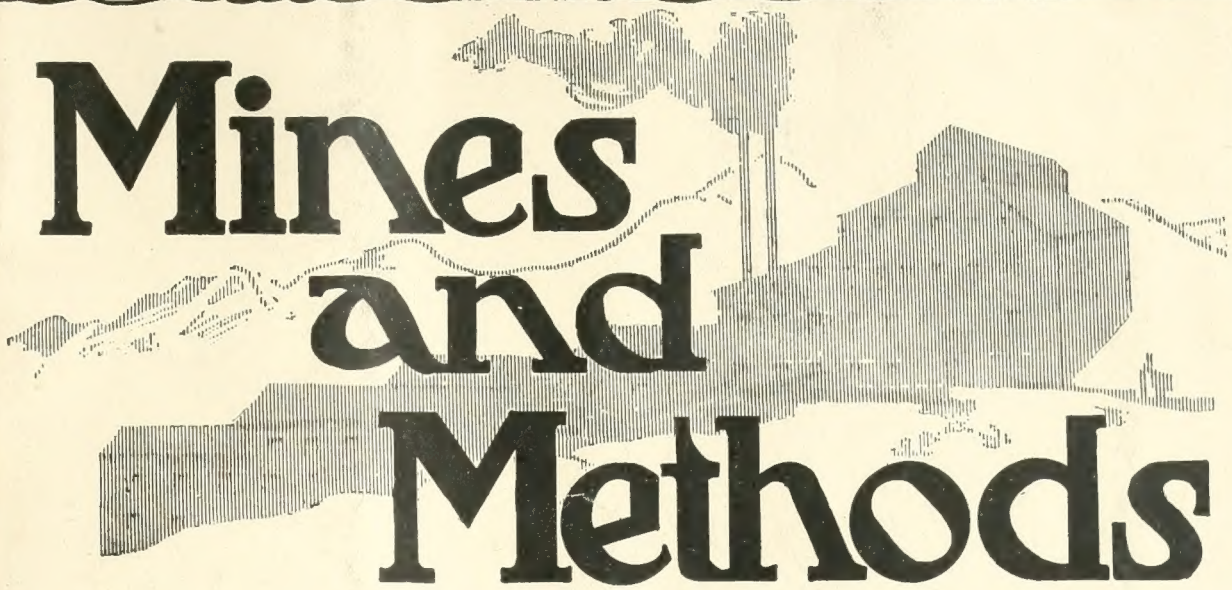

IN THIS ISSUE

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IN THIS ISSUE

The Messrs. Guggenheim Are Seeing the Light

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"Who Taught Salt Lake City to Smoke?"

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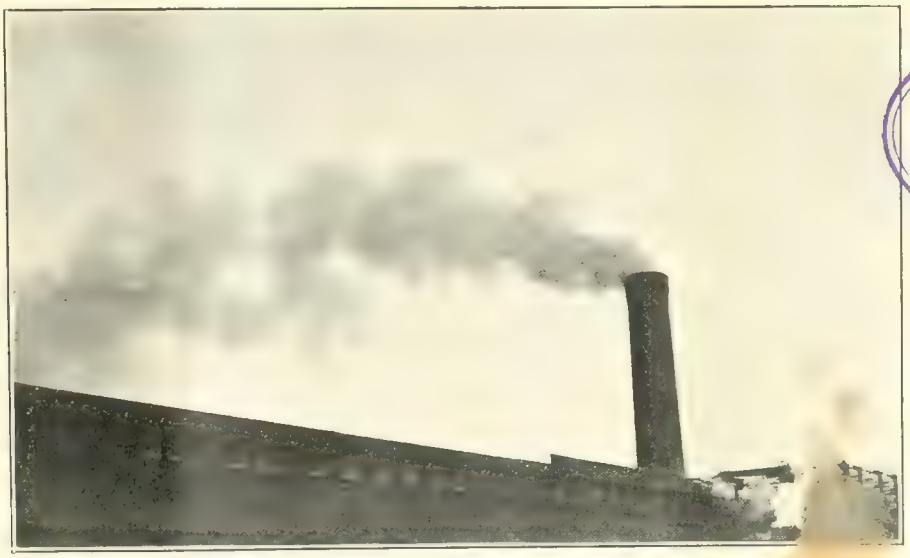

More smoke flows from this Murray smelter stack in a year than from [illegible] fires of Salt Lake City, if we compare the amount of solids burned in the furnaces at the base of the stack.

Following the Smoke Trails

By J. CECIL ALTER

Salt Lake City, Utah
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IN THIS ISSUE

Additional Findings of Fact in Smoke Trailer's Path

By J. CECIL ALTER

Commercial Club Tackles the "Smoke" Problem

"Garfield" Milling Methods a Failure

Salt Lake City, Utah
MARCH, 1913

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IN THIS ISSUE:

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Mines and Methods

IN THIS ISSUE:

Inside and Outside of Alaska Gold Mines Deal

Problem Now Confronting Bingham Porphyry Operations

The Art of Mining the Public

Salt Lake City, Utah
MAY, 1913

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IN THIS ISSUE:

Tipsters and Tippees In the Mining Business

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CONTENTS:

Please notice that this issue of Mines and Methods begins the fourth fruitful year of the publication's existence. It has not experienced in the three years just closed one dull moment. For the stand it has taken in working for a square deal in mining, such as prevail in other lines of commercial endeavor, it has been showered with congratulations from all parts of the world. It has been impossible to make personal acknowledgment of all these, but we wish our friends and patrons to know that we feel grateful for every kindly expression that has ben made to us and that we shall in the future, as in the past, do the best we can to deserve the same. When Mines and Methods was started some of our best friends doubted the wisdom of the move, while others became sportive and wanted to wager that not more than three or four numbers would see the light of day. Well, thirty-six numbers are now on file, and here we go for another dozen. Send in your dollar and get a receipt for it.

THE STRIKE AT BINGHAM

Mines and Methods is not an advocate of strikes. It is deplorable that differences between employers and employed cannot be amicably adjusted without recourse to such destructive measures; but, weighing causes and conditions that impelled more than 4,000 men employed at Bingham to lay down their tools and walk out on the 18th of the present month, there seems to be no question but what the management of the Utah Copper Company is directly chargeable with bringing about the calamity. If that company has been telling the truth about its enormous earnings; if it is true, as the company's sponsors are continually declaring, that the company's earnings now amount to more than $1 a share a month on its more than 1,600,000 shares, then we say that the men who are daily taking their lives in their hands to serve the company are perfectly justified in demanding a raise from $2 to $2.50 per day for blasting and removing the rock from precipitous mountain sides; as also are those who are working in dangerous underground positions if they demand $3.50 instead of $3, or $3 instead of $2.50, as the case may be, when they know that men better treated and better taken care of, at Butte, for instance, are receiving an average of practically $1 a day more than the scale which their present demands call for? If the Utah Copper Company is doing anything like it claims, it is better able to pay miners even $4.50 per day than are the companies operating in Butte and the demands of the men ought to be met without a sign of protest.

On the other hand, if it should develop that the company is not earning at the rate claimed by it—and that was practically admitted by Manager Jackling Friday last when, in an interview with the Tribune, he said that, "nothwithstanding the present high price of copper, the operations of the company have not yet fully reflected this condition"—and if the real truth is, as repeatedly shown by this journal, that the management plays fast and loose with the shareholders of the company and the public in its vain attempts to create a "bull" market for the stock of the insiders, we then also maintain that the wages demanded by the men are not too high nor are they unreasonable.

During the year 1911, according to statistics published by a camp paper, nearly 1,000 men in the employ of the Utah Copper Company were victims of accident. Twenty-nine of these were killed and the rest were either permanently maimed or seriously injured. Not all of the other mines of Utah combined could be charged with such wanton disregard of the welfare of their employees as that, and it is not strange that finally the men, learning of the constantly claimed, boasted and paraded fabulous earnings of the Utah company, decided they should be better paid for their work and flirtations with death while accomplishing such results. Then the men charge that through a Greek employment agent of the Utah Copper Company they are required to pay a large sum to secure a job with that concern, while it was claimed by a camp paper several months ago that representatives of the company secured a portion of the blood money thus squeezed from the poor devils imported and unloaded at the company's mines just as so much inert machinery might be.

This controversy places the Utah Copper management in a bad hole and from the looks of things it will either have to make a lot of humiliating admissions or "come to time." More than a month ago the company saw what was coming and it undertook to prevent the breaking of the storm by announcing that certain classes of its employees would be given a "voluntary raise" of 25c. a day on September 1, which only placed the rate back to what it was when a previous cut was made, and when the company was just as strenuously declaring—away from home—that its dividend of $3 a share was being much more than earned.

Mines and Methods has regularly, consistently and insistently contended that the Utah Copper never has been the great earning proposition that it claimed to be; that had it not been for the periodical acquisition of new ground with real ore in it, coupled with the numerous sales of additional new stock, or the borrowing of money, it never could have maintained its position. We believe it is still in that position and had it not so blatantly proclaimed its false premises to the world it would not have created such a feeling of resentment from the miners of the camp

in which its properties are located. How the management is going to be able to recede from its position of a tremendously successful "self-contained manufacturing enterprise" and still maintain the confidence of the investing public (if it ever had it) is something we are unable to see. On the other hand, if it grants the demands of the men and continues its bold front, it will not be long until it will have to face a demand for another increase, as the example of the Butte miners will be constantly pictured to the men who do more hazardous work and still get much less for it.

The Utah Copper Company has been sowing the wind for several years; it is, apparently, just beginning to reap the whirlwind.

Utah Copper to Absorb Ohio

Considerable mystery surrounds the examination of the Ohio Copper property that is now being made. Several months ago Allen H. Rogers, then representing the Nevada-Utah interests, was in the camp examining the Last Chance claim. Since then he has returned and, it is understood, that he is now representing the Hayden-Stone interests of Boston. * * * On account of the close association of the Utah Copper with the firm of Hayden-Stone & Co., it is pointed out as possible that the company will take over the Ohio Copper company.

According to this statement, which is taken from the Bingham Review, a camp publication that is looked upon as the Utah Copper Company's personally owned mouthpiece, the long-expected is about to happen. Mr. Fritz Augustus Heinze, seemingly, is going to receive his price for the relinquishment of the Mascotte Tunnel and it is safe to predict that he is going to be well taken care of, so far as his stock interests in the Ohio Copper is concerned, as a part of the bargain. The rest of them, those who have paid their $1 a share for the purpose of aiding in the reorganization and payment of the outstanding obligations of the old company—or at least those not "in" on the deal—can take the 25c. a share for their old holdings, originally provided for, (if not yet turned in) or possibly get $1.25 for their new stock, with the $1 assessment paid.

Until the Bingham paper was prompted to "gently break the news" it was supposed by a great many innocent Ohio shareholders that the reorganization and assessment plan was arranged with a purpose of really pulling the company out of the hole. But no such luck. In effect, if appearances indicate anything, it is to be a repetition—on a smaller scale—of the Boston Consolidated and Nevada Con.-Utah Copper deals, where the insiders fixed the terms and the outsiders were compelled to take their medicine. If the deal goes through, and there is no reason to suspect that it will fail, those who have lost heavily in Ohio will have the knowledge that there is nothing to prevent them buying Utah Copper shares and, to make the settlement with Mr. Heinze and the rest of the insiders easier, those who get buncoed in Ohio will likely be granted the privilege of taking a stated portion of the new shares of Utah Copper stock that will, without much question, be sold to meet the purchase price of the Mascotte Tunnel property from Mr. Heinze. To make this new stock issue look all the more attractive for this play, the Utah Copper market manipulators have been steadily "washing" the price up for more than a month past. This feature of the scheme has been working in the face of a market that every half-honest reporter has repeatedly shown to be wholly professional—in a market which the public has been leaving severely alone for so long that even Daniel Guggenheim became discouraged and sailed for foreign lands bent on finding customers for his "securities" elsewhere.

These few remarks are offered so that the lay shareholders in Ohio may be enabled in a measure to grasp the situation and decide for themselves what is best to be done in case they find themselves in the boat that such a consummation of their utter route as we have outlined is visited upon them. We cannot swear that it will turn out just as we say—we simply draw our conclusions from what has happened before.

As for ourselves, we have long believed that Ohio and the Mascotte Tunnel properties would go the Utah Copper, because it provides the only outlet for the underground ore of the latter company. The first move in that direction came when the Utah Copper Company secured permission to extend the Mascotte Tunnel workings a distance of some 1800 feet in order to connect with the Hayden drill hole, sunk from the main pit of the Utah Copper's steam shovel workings; it became more apparent over six month ago when Utah Copper experts were engaged in sampling the Ohio mine. Both of these events were recorded by Mines and Methods at the time, and their significance was pointed out.

At different times, lately, the Utah Copper's publicity agents have told of the drill-hole prospecting at depth which has been going on and—as this work is said to have shown that, within certain prescribed and narrow limits bordering the Quinn fissure, ores carring 2 to 4 per cent was encountered—the natural thing to expect has been that a means of getting at this ore would have to be provided, at stated above. It does not appear that much is to be expected from Ohio ground at depth and it is claimed that only a few unimportant streaks of ore were found in running the 1800 feet from the Mascotte tunnel's workings, through Utah Copper possessions, as related above.

Those of our readers who have been following what we have had to say concerning the management of Utah Copper affairs from the beginning will remember that when the company, more than three years ago, was claiming that it had a self-contained manufacturing proposition, we showed that it had nothing of the kind; that it would be down and out within two years if it depended on making money with its steam-shovel methods of mining, in the territory it then owned. It will be recalled that our statement to this effect was fully justified inside of six months, when the company was compelled to secure the Boston Consolidated—not only to secure working room for the steam shovels, but also to secure underground ore with which to 'sweenten' its steamshovel product sufficiently to give it the appearance of being commercially valuable.

When that deal was consummated, and knowing conditions, we made the declaration that even the Boston Consolidated acquisition could be relied upon only to defer the day of reckoning for probably another year or so. Within the next six months the Utah company was forced to buy the Barnsdall group of eight claims—in fact, it had to buy this group twice, for when the original deal was made the owner did not know that the Utah Copper Company had been mining out the rich ore from the group for a long time previous; but when he found it out, through Mines and Methods, he compelled the Utah Copper Company to shell out 6650 shares of its stock as a pacifier. That purchase of the Barnsdall group has saved the life of the Utah Copper Company up to the present time; it also has clinched the statement of Mines and Methods that the company must continue to secure new ground with real ore in it or quit.

Three years ago, and every few months since, the management of Utah Copper has been declaring in its reports that it would soon be ready to discontinue underground mining altogether; but each succeeding report has shown that, had it not been for the ores secured underground, "possible" and "probable" ore would have been about all that it could have supplied to its mills. These matters are mentioned to show that Mines and

Methods has never made a single mistake in dealing with the mismanaged affairs of this company. Our contention that it was impossible to profitably conduct steam shovel mining operations at the property has repeatedly been verified and emphasized in the different issues of new stock, or borrowing money against the sale of which has been necessary to meet the enormous expense of removing overburden, remodeling mills, etc., in order that the receipts from the sale of copper might be made to appear sufficiently profitable to justify the payment of dividends.

Only a few months ago no less an authority that Mr. Heath Steele, a prominent mining engineer of New York, showed conclusively that if the Utah Copper Company had properly charged to production of copper what should have been charged against it, the 1911 dividends would be shown to have not been earned by $1,500,000 at least. For the last two years and more every successive report of the company has shown that the grade of the ore treated was diminishing, until now it ranges at about 1.2 to 1.4 per cent, and this with all the "sweetening" that can be given it by the addition of the better grades of ore coming from underground workings in the Boston Con. and Barnsdall areas. In the meantime the amount of overburden that the steam-hsovels are required to handle is increasing at a rate which, as the months go by, will climb to proportions that even a 17¾c. copper market cannot sustain.

In the face of it all, and while an effort is being made to convince the world that the company is making a clean profit of better than $10 a share from its Bingham operations—as a result of its "magnificent" steam-shovel methods—the management seems to be dickering for a chance to add other properties to its holdings in order that underground mining may be continued and the deception it has practiced may not become apparent until the public shall have been bamboozled into relieving the insiders of the burden they have been forced to bear for the past four or five years in absorbing the floating stock and sustaining the market.

———o———

To clean steel tapes that are badly rusted, the use of a mixture of lubricating oil and cement is efficient. While no particular proportions are necessary, it should not be so thick that difficulty results in using it. Care should be taken not to rub too hard as the action is powerful and, used without judgment, wears off the metal.

THAT "MILL ROLLER" SUIT

On the 16th of the present month the Salt Lake Engineering Company filed a suit in the Federal court for $36,000 against the Ohio Copper Company claimed as due for ten sets of Wall's corrugated, horizontal crushing rolls and ten sets of Wall's vertical rolls, all of which, with the exception of four sets of corrugated rolls previously installed, were placed in operation at the Ohio company's mill, at Lark, Utah, between September 25, 1911, and February 20, 1912. In the abstract there is nothing in this of particular public importance, and the matter would not be mentioned here only that from the first day it became known that the Ohio company was going to equip its milling plant with the Wall patent rolls, no opportunity has been allowed to pass by interests unfriendly to the patentee of the rolls to prejudice the mining profession against their adoption and use in ore-reducing plants.

The filing of the suit in question was the signal for a portion of the local press —the Evening Telegram—to state that this $36,000 was "alleged to be owing for A SET OF MILL ROLLERS," certainly cognizant of the fact, through their familitary with ore-treating practice, that such a statement would seem ridiculous and tend to cast aspersion on the inventor and the claim for remuneration by plaintiff company.

It is due to all parties in interest that something of the truth should be known. Since the first installation of the Wall crushing rolls in the Ohio mill the company adopting them has been able to make a showing that it never previously dreamed of making; where it was previously losing a great deal of money on the treatment of much better ore than it has handled for many months past, the management has been able to show in official reports that its net earnings had reached more than $35,000 per month; that in the last year these net earnings had exceeded $300,000. In the face of statements made by the company's management showing what good work the Wall rolls had been doing, eastern market publications, inspired, unquestionably, by subservient tools on this end of the line unblushing declared that Wall's "contrivances" had failed to disclose any merit Such dainty morsels of misinformation have been reproduced by a sycophantic local press with utter disregard of any favorable mention that may previously have been made on authority of Ohio officials, and with a purpose, apparently, of doing the bidding of some one to break down and crush anything and everything that is not initiated and promulgated as worthy from as miserable lot of incompetents as ever afflicted the mining profession.

The terms of the contract under which the Ohio company was enabled to install the Wall rolls could not have been more liberal. If they did not do all that was claimed for them the company had the right to return them in whatever condition they might be, without cost to the provisional purchaser. For mutual reasons the price was made extremely low and payment was to be made only from net earnings of the company. And, while the company has been reporting substantial net earnings for many months no proffer of payment for the crushing installation has been made to the Salt Lake Engineering Company, which supplied it.

The bringing of suit for collection was prompted, not through any desire to cause the Ohio company trouble, but because it has been apparent for some time that the control of the company and its mines and mill would pass into the hands of a corporation known to be hostile to anything or anybody having the remotest connection with the name of the inventor of these peerless crushing machines, machines that have demonstrated the Ohio Copper Company's ability to make money in a small mill on ore carrying barely 1% copper at a much better rate than has ever been possible with 1.5% ore in the mammoth mills of the Utah Copper Company, for instance.

These facts are related in the interests of truth and for the benefit of those whom it has been the evident purpose of purveyors of falsehoods to deceive.

———o———

The reason that window panes are whitened in a building not yet completed, is explained by a building contractor as reported in the New York Times. "We don't plaster them over with chalk to prevent the public from seeing the unfinished condition of the interior, but to keep the workmen from battering out the glass. Transparent glass looks just about as transparent as air to the man who is moving a wooden or iron beam in a hurry, and he is likely to ram the end of it through an expensive window, but when the glass is coated with white it becomes visible, and the workmen hand their material in through the door."

———o———

The life of machinery depends upon the treatment that it receives.

———o———

To preserve iron against rust, immerse it for a few minutes in a solution of blue vitriol, then in a solution of hyposulphite of soda, acidulated with chlorydric acid. This gives a blue-black coating which neither air nor water will affect.

UTAH COPPERETTES

No matter what the ultimate outcome of the strike at Bingham may be, it is not believed that it will be extended to the properties of the Alaska Gold Mines Company, in the mountains back of Juneau, even though they are under the management of Mr. Jackling.

* * *

The "New York Curb" devotes a great deal of its space these days to the stereotyped boosting literature of Utah Copper, Braden, Ray Con., Chino and Alaska Gold Mines, thus suspiciously indicating that it, too, is out for the dough. If it keeps "in tune," however, it will have to cut some of that "Spencer" stuff, because it is sure to detract from the "investment" value of the boost dope referred to.

* * *

Brokerage papers, "Market Letters" and correspondents of different mining magazines and newspapers, have been bowling along an interview with William B. Thompson, recently returned from a pleasure trip through Europe, in which he is made to say that "one firm of bankers in Paris has accumulated 250,000 shares of Utah Copper and is still in the market." We have known all along that strenuous efforts were being made to unload Utah Copper shares in France, but we did not suppose that one firm of "bankers" (or brokers) had been commissioned to try and sell so many; and we use the word "try" advisedly, because all the reliable evidence of the past year's struggle on the part of the Utah Copper Company's publicity department to create a demand for the stock—and particularly in France—has proven anything but "a howling success." These 250,000 shares referred to by Mr. Thompson are probably those which remained of the 300,000 originally listed by individual owners three years ago, and which have not yet been returned to this country. Mines and Methods showed more than a year ago that practically all of the first shares sold in Paris were thrown on the market at a loss by the Frenchmen who had bought them and that they were all taken in by the Utah company's representatives in this country. Again, it may be possible that the entire holdings of Mr. Thompson, consisting of 50,000 shares, all of which it is said were disposed of at about that time, have found lodgment in the strong box of some fool Frenchman. This, together with the number of shares mentioned by Mr. Thompson, would account for the entire amount listed, as related in this magazine at the time.

"The report of D. C. Jackling and A. F. Holden covering the Alaska Gastineau property should be studied carefully by investors who fancy shares in precious metal mines," says the New York correspondent of the Mining & Scientific Press. In this we fully concur, and to make it easier for investors we are reproducing that most illuminating document in this issue. We shall also give it space next month, so that men who do "invest" may commit it to memory and forever after know just what kind of bait they swallowed.

* *

"Copper stocks were all firm. Utah Copper was picked up by bargain hunters, as were Chino and Ray Consolidated."—From Shotwell's New York market dope in Salt Lake Tribune of Sept 20th, just after the miners' strike at Bingham. In the same issue (Logan & Bryan market letter) we find this: "Utah Copper suffered from the liquidation incident to the unsettled state of affairs in the Bingham camp. * * * Of course, in the case of mining equipment being damaged, the company loss might be great, but from the standpoint of ore reserves, etc., the property could not be damaged." Of course not. Who could damage ore reserves the "indicated" recoverable values in which amount only to about fifteen pounds of copper per ton? Besides, you have seen how great tonnages are added to the reserves of the Utah Copper mines by simple calculations and revisions of the mine maps, as was done in the annual reports of the company for 1910 and 1911 when more than 200,000,000 tons were added by just a few strokes of the managerial pen.

That Mr. Jackling is a wonderful manager is not questioned in the least. The past ten years have brought him from an obscure position, as a metallurgist for a small mining company, to the position of the leading mining man of this country today. But, notwithstanding this, Mr. Jackling has had failures and a number of them. We can mention quite a few properties that have not been the success he and his associates in them have anticipated, and for this reason it would be well to thoroughly investigate the possibilities of the Alaska Gold Mines company before rashly making an investment in these shares. * * * We read that in his latest venture * * * over 2,000 stockholders have been enrolled on the stock ledger of the new company. We venture to say that not five per cent of these have investigated the proposition. * * * The lowest cost ever given on mining underground ores in the Utah Copper is 68c. a ton and the orebodies in this ground are several hundred feet in width and quite soft and easy to handle. Should the Alaska ores be mined equally as cheap, there would still be the milling costs to add to this amount and, if it became necessary to use cyande, the costs would probably run a great deal higher than the small amount allowed for this purpose.—Excerpts from Market Letter of Dern & Thomas, Salt Lake.

What do you think of that? Did you ever before—outside of the pages of Mines and Methods—see or hear of anybody in cold print questioning the infallibility of Mr. Jackling? And right here in his "home town," at that! To call Mr. Jackling a "wonderful manager" and then to charge him with having a number of failures to his credit and at the same time to almost threaten him with exposure by declaring that " we can mention quite a few," is certainly going some. "Tintic," the title under which the market letter referred to is issued, has evidently not been "gathered in" and "greased."

Judging from the remarkable "strength and activity" of Utah Copper stock on the New York exchange since the company's mines and mills were closed down as a result of the strike, it would not be such a bad thing for the companies if the president of the Western Federation of Miners did follow up his threat and cause a close-down of the Ray and Chino. When it can be shown that a mining company, so far, at least, as the market price of its shares are concerned—is worth more "dead" than "alive," what's the use of being burdened with the bother and expense of operating? Eastern brokers and other "bull" dopesters, including the "echoes" on this end of the line, have been explaining for ten days or more that the closing of Utah Copper is going to create a famine in the copper metal market and, as the price of the metal must as a result advance, so are the shares of company stock worth just that much more, particularly as the "ore reserves" cannot be either damaged or frittered away by the strikers. That's the stuff!

———o———

When boards have become dished, that is, hollow on one side and rounded on the other, they may be straightened by exposing them in the sun, round side up.

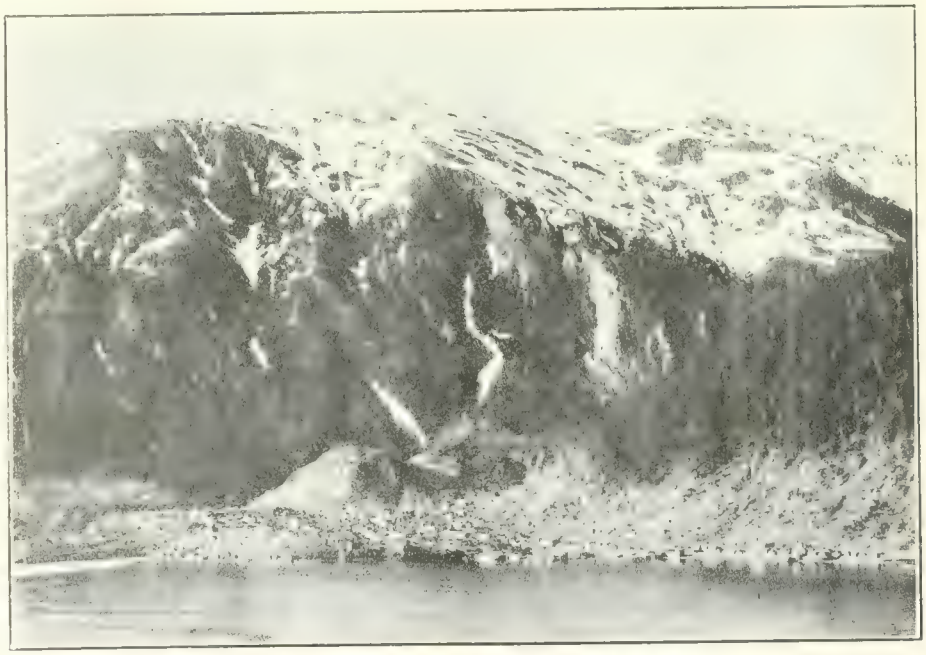
Promotion Cogs Slip in Alaska Gold Mines

Overpoweringly intoxicated with the apparent success of the flotation of the new Alaska Gold Mines Company's first offering of shares, or else thoroughly frightened at the prospect of ridicule which they felt must follow an effort having for its object the commercialization of vaunted names of engineers, brakes were applied by Hayden, Stone & Co. to the distribution that was to have taken place one month ago. "Bankers and brokers" the country over apparently were quick to perceive the purposes of the "play" and they applied for substantial-sized blocks of the stock; these masters in the art of market trafficing saw what the game was and they decided to rake in as many shares as possible "$5 paid," and promptly fire them back again for the profit they knew must follow the determination of the promoters to jump the price up. Without considering any other feature of the proposition, the promoters evidently were just as quick to discern—from the nature of the applications for stock—that, should they recognize the applicants, they would be compelled to disgorge the difference between allotment payment of $5 and the washed-up market price, so they discreetly declared that owing to the heavy demands of inside interests for the shares it would be impossible to make the promised pro-rata allotments.

It is possible, however, that the promoters have deceived themselves to the extent of believing that the SEEMING popularity of the offering would make it easy for them to retain the stock and sell it out to the public at $8 to $10 a share, or at a premium over the "$5 paid" of $3 to $5 a share. In this calculation, judging from the apathy displayed by the public, the promoters have "reckoned without their host," and the shares still repose in the strong boxes of those responsible for the flotation scheme.

Last month's issue of Mines and Methods contained the text of the promoters' circular, including the "report" of the eminent engineers who recommend it, and, while every word used by Hayden, Stone & Co. was included in our story, the public seemed to view the matter in a different light than that reflected in the brokerage presentation and would-be "investors" closed the clasps on their pocket-books and decided to hold aloof pending further enlightment on the subject. Last month we had opportunity only to give a glimpse at the scheme of the promoters of this "wonderful proposition" and to predict utter failure as the ultimate outcome.

Readers, we are sure, will agree with us that there was nothing in the original presentation of the proposition, as given in detail in the last issue of this magazine, to convince a prospective investor that there was even a reasonable chance for success. Hayden, Stone & Co.'s letter was flagrantly indefinite as to detail and it must be admitted that the 'report" of Engineers D. C. Jackling and A. F. Holden (which is reproduced in this issue for memory-refreshing purposes) contains nothing—absolutely nothing—by which the real commercial value of the undertaking may be guaged. So we are going to help out a little by giving our readers a peep at the country in which it is proposed to operate, together with a few pointers touching the chances for success—something to help in figuring out just where they may expect to land if investors persist in chasing this golden rainbow.



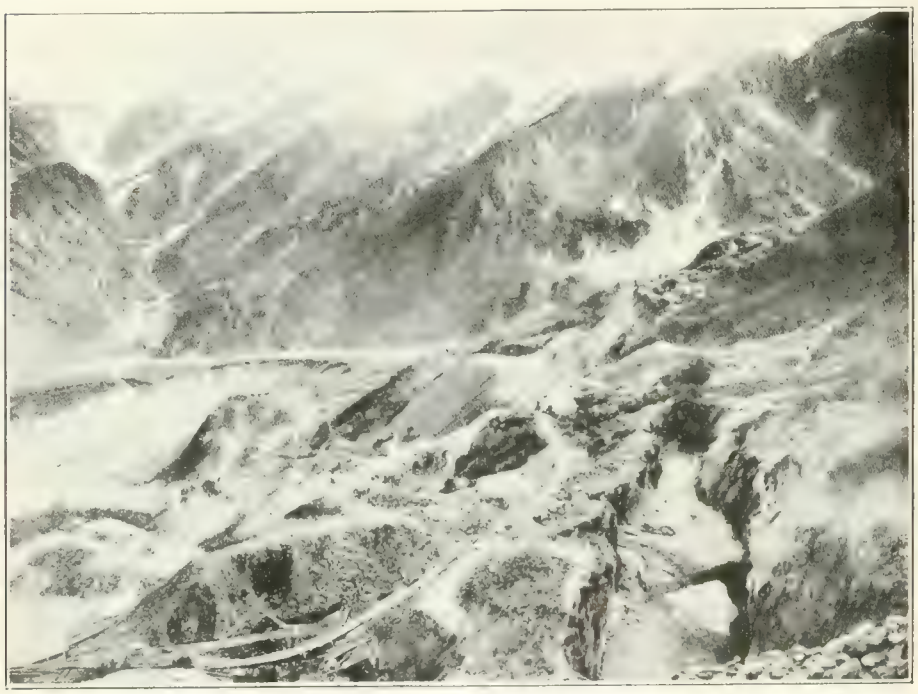
Gastineau Channel and City of Juneau

The pictures and sketch map presented herewith are reproduced from Bulletin No. 287, U. S. Geological Survey, on "the Juneau Gold Belt, Alaska," by Arthur C. Spencer. These half-tone pictures and sketch map of the Gold Creek district, studied in conjunction with the "report" of Messrs. Jackling and Holden, and our review, will give a far idea of the value of the "report" of these eminent engineers, particularly as it relates to the chance of making a profit of 75c. a ton on ore the recoverable value of which they "indicate" to be $1.50 per ton.

The first half-tone gives you a picture of Juneau and a portion of the mainland coast line south from that town (at the mouth of Gold Creek canyon) in the direction of Sheep Creek canyon, between four and five miles southerly from Juneau. The water in the foreground is that of Gastineau channel, which divides the mainland from Douglas Island, on which is located the Alaska Treadwell group of mines, the surface workings of none of which have an elevation of more than 500 feet above sea-level and all ideally located as contributing factors in low-cost mining, milling and transportation problems. Note the precipitous character of the mountains in the picture showing Juneau; then imagine yourself climbing the canyon to the left and back of that town for a distance of some four or five miles and a perpendicular raise of 2000 feet or more and then glance at the second half-tone, in the foreground of which your climb would land you. Then study the view, which is in a southerly direction over and through the Perseverance property, (which the Alaska Gold Mines

company has undertaken to buy), to the Sheep Creek divide, over which the southerly limits of the new company's prospective possessions is claimed to lie. Turn from this picture to the sketch map and you will see how the ground lies with respect to the new company's field of operations and how the Geological Survey's engineer has outlined the trend and width of the mineral zone. According to the government's topographical map of this region most of this territory embraced in the new company's prospective holdings ranges in altitude from 2500 to over 4000 feet above the Gastineau channel, or sea level.

The new company's eminent engineers explain to you that it is the purpose to drive the proposed Sheep Creek tunnel on the vein as the main haulage level (see second paragraph of the Jackling-Holden report), and if that is so and the Geological Survey's sketch of the



Upper end of Silver Bow Basin, Gold Creek, Looking Southeast Toward Perseverance and Groundhog Groups and the Sheep Creek Divide, Showing Nowell Placer Workings and Several Open Pits of the Alaska-Juneau Mine.

mineral-bearing lode is even approximately correct, mining operations will be conducted from a point about 2000 feet in the air above the level of the Gastineau channel, up Sheep Creek, and over the divide shown in the distance or background of the accompanying half-tone picture of the Gold Basin-Sheep Creek region. Everything thus shown and explained makes it plain, does it not, that particularly cheap mining in this region is not to be expected, no matter what claims are made?

Since the government report referred to was issued the promoters of the Alaska-Gastineau company, or its predecessors, owning the Perseverance property, built a mill of 100 tons daily capacity on the property and Mines and Methods has it from a reliable source that it cost $75,000 to move the material for it up the canyon from Juneau. If the new company is to build a mill with 6,000 tons daily capacity at the mouth of its Sheep Creek operating tunnel—and it costs no more to deliver material, machinery and equipment at that bird-haven than it did to the Perseverance, $750,000 will do the hauling. But that is an item of cost hardly worth considering in a proposition where it is BELIEVED the ore can be made to yield $1.50 a ton! and it would not be mentioned here, only that we hope to interest possible investors in doing a little figuring before they "cast their bread upon the icy waters" of Sheep Creek or the Gastineau channel.

According to reports which come to us unsolicited the operating company mined out the three richest shoots of ore in the Perseverance property (this was probably the ore on which the engineers of the new company base their estimates of $1.50 "indicated" recoverable value) and managed to get so far in debt that the holders of their bonds and notes have been glad of the chance offered to enlist the services of the great engineers and promoters identified with the flotation of the Alaska Gold Mines Company, to pull them out of the hole.

Since the organization of the Alaska Gold Mines Company considerable space has been devoted by the subsidized boosting press to accounts of what is done at the Alaska Treadwell properties, all with a purpose, of course, of indicating what "tremendous possibilities"—and, a la Jackling and Holden, we use the term "tremendous" advisedly—exist in the properties of the new company. Just after Mr. Jackling's return from the east the Deseret Evening News of this city (Sept. 2,) prefaces its remarks concerning Mr. Jackling and the new flotation with a lot of stuff concerning the operations of the Treadwell which begins in this way:

BIG OPERATIONS OF ALASKA TREADWELL

Company Makes About $1 Per Ton Profit on the Ores Treated—Gold Yield About $2.50.

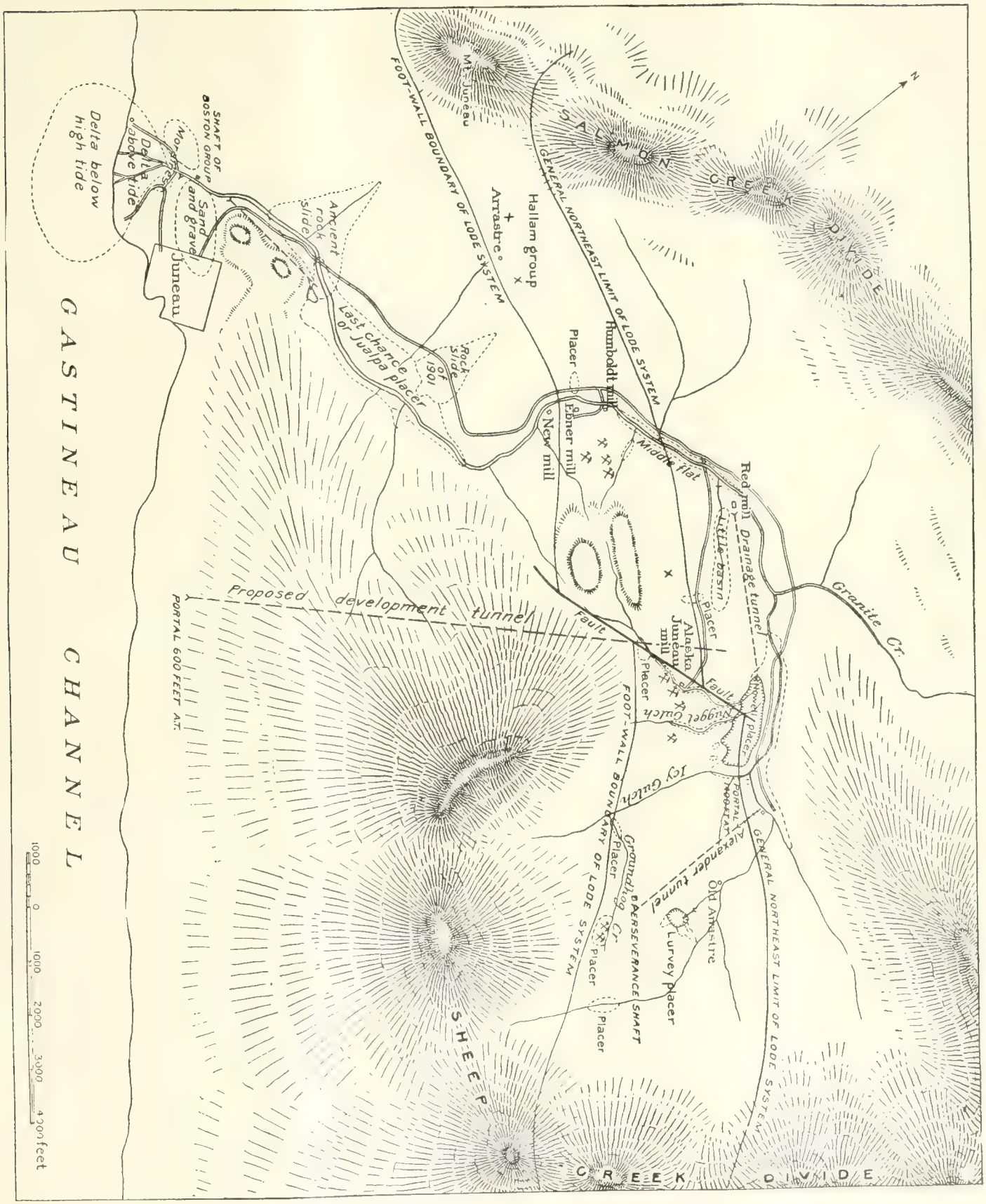
With the gold mining properties in Alaska taking a conspicuous place before the public, and the enormous scale on which future enterprises are being planned, an account of the operating of the Treadwell property is not amiss at this time. The following is an account of the operations of the property for a recent month: Running a 240-stamp mill for 30¼ days, and a 300 stamp mill for 19 days, the Alaska-Treadwell company crushed 64,120 tons of ore. The total yield of gold was $160,000, or less than $2.50 per ton. The net profit was $64,000, practically $1 per ton.

Of course, if the unsophisticated mining reporter for the paper quoted had submitted that statement to Mr. Jackling before he had turned it in for publication it would not have been given publicity, as it shows perfectly how impossible it will be for the Alaska Gold Mines Company to ever make a cent out of ore in which there is recoverable values of only $1.50 per ton. You see the Treadwell company, for the period referred to, was operating on ore with recoverable values of $2.50 a ton and making a profit of $1. In other words, if the Alaska Treadwell company, with its magnificent facilities for doing inexpensive work, backed with experienced, high-class, honest management, had been operating on ore from the Alaska Gold Mines properties, every cent of the recoverable value would have been absorbed in the cost of producing it.

That being true, how does the investor expect that a proposition like the Alaska Gold Mines is going to win out, particularly when it is placed in hands which, with all the millions at command and with what is claimed to be the simplest mining and milling proposition in the world, a few miles from Salt Lake, where supplies, labor, freight and all other conditions are ideal, has never been able to approach the Alaska Treadwell record given by the News:

Before closing this review of conditions enshrouding the new company let us refer briefly to the Geological Survey's Bulletin and quote a few lines from Mr. Spencer's report. And here let us digress long enough to say that Engineer Jackling and Holden's "report" was based on personal inspection following submission of reports to them by mysterious, UNNAMED engineers:

As in the other mines of Gold Creek, the



Geological Survey's Sketch Map, showing the Location of the Perseverance Property and the Sheep Creek Divide, Over and Beyond Which the Alaska Gold Mines Company Says It Will Operate. Limits of Lode System is also Shown.

Perseverance deposits are stringer leads in which the vein stuff is distributed through the country rock in the form of irregular vein fillings. The black slate, which is the principal rock, is intruded by numerous dikes and both of these rocks are cut by the ore stringers. * * * The structural trend of the country is about N. 40° W., as shown by the slaty cleavage, the course of the diorite dikes and the strike of the foot wall of the slate band in contact with the greenstone. * * * Mineralization extends through nearly the whole length of the lode system in Gold Creek, and is continued on the Sheep Creek side of the divide toward the southeast. * * * From the Ebner property on Gold Creek to the Silver Queen mine in Sheep Creek the distance is about five miles. The Ebner ores contain gold and silver in the proportion of about 7 to 1 by weight, while in those from the Sheep Creek mines the amount of silver is several times that of the gold. It seems that there is a progressive increase in the proportion of silver from northwest to southeast, for on the Perseverance ground the silver is from three to ten times the gold by weight, as shown by a large number of assays made for the Alaska-Perseverance company. * * * On the Perseverance property the veins are very much broken, so that it is impossible to mine the vein stuff separately from the country rock.

Time and space forbids going farther in this delineation of the fallacies of the so-called "tremendous possibilites" of this magnificent (?) propositon which, in the presentation by the promoters, is counted as "analagous to the low-grade 'porphyry' mines," with the added advantage, of course, that gold is not subject to market fluctuations, like copper.

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FOR TRUTH OF HISTORY

Editor Mines and Methods:—In your August issue, this year, is a very valuable and interesting article, by C. F. Z. Caracristi entitled "Mineral Development South of Canal Zone." The subject would fill a book; but he has condensed it to the limits of his article and yet makes a most readable presentation. The region described is, acre for acre, all things considered, the richest in the world. Panama was only a province of Columbia, until our government forcibly wrested it from her, and the eternal verities require that we should return it to her, which can be done at no cost to any one. She has always been a devoted friend of the United States, and would make a better neighbor than its present government and people.

My object in writing is more than for anything else to correct an error. Senor Caracristi has fallen into, and others, more than he. He says:

"The interior of Columbia presents a vast field for future development when the railway facilities are to be had for getting into ths country, and when the canal is completed and the proposed inter-continental railway—the dream of the late Hinton R. Helper, who projected the idea before a convention in the city of St. Louis in 1848—becomes an accomplished fact."

The truth of history is that Colonel William Gilpin, Colorado's first territorial governor, was the person that made the speech on the subject and at the time named. He was then and had been for a long time a resident of Missouri. In 1873 he published a book entitled, "Mission of the North American People." Its introductory page has this legend:

"The Central Gold Region; the Grain, Pastoral and Gold Regions of North America, with some new views of its physical geography and observations on the Pacific railroad, by William Gilpin, late of the United States Army. First published in 1860."

In that first publication is a map of the world, his own, "Delineating the Contrasted Longitudinal and Latitudinal Form of the Continents; the Isothermal Zodiac and Axis of Intensity, Round the World, and the Line of the Cosmopolitan Railway and its Longitudinal Feeders."

In that 1860 publication was laid down, among others, a line of railway up and down the Pacific coast of North and South America. Mr. Helper evidently was ignorant of Gilpin's work, and believed his was the pioneer thought. In confirmation of that belief and of my correction, I submit the following from a letter he wrote on the 30th day of November, 1896, to his friend:

"His Excellency, Hon. Eurique Dupay de Lome, Envoy Extraordinary and Minister Plenipotentiary for the Kingdom of Spain, Distinguished Sir: * * * This being the 30th day of November, 1896, which is one of my most welcome and delightful anniversaries, I am vividly impressed with the fact that it is just thirty years today since I conceived, under somewhat extraordinary circumstances, the idea of an inter-continental railway through the three Americas, from Behring Strait to the Strait of Magellan, which, when built * * *"

This was six years after Governor Gilpin had mapped and elaborated the idea, and as I stated above, it is due to the truth of history these things should be known. I was familiar with his two books, and besides was honored by his personal friendship.

HENRY ALTMAN.

New York, Sept. 7, 1912.

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MINE FOOD FOR WINTER

In the accompanying table is given a list of groceries and provisions consumed at Iron Mountain, Idaho, by twenty men (average) including cooks, during four winter months in 1909 and 1910, says Percy E. Barbour in the Engineering and Mining Journal In addition to the list, lard was fried out of the two hogs listed as fresh pork. There were not enough fresh vegetables to last through the period and owing to the winter season and snow-blocked roads, the camp was snowbound practically all of the period, no more could be obtained and their place was taken by canned goods. Double the amount of cabbage, turnips, parsnips, and one-half more onions and carrots should have been provided. In addition to the list were used sundry small amounts of spices.

Fresh beef	2383 lb.
Fresh pork	581 lb.
Fresh mutton	167 lb.
Fresh fish	100 lb.
Fresh chickens	112 lb.
Fresh eggs	69 doz.
Case eggs	6 cases
Ham	472 lb.
Bacon	258 lb.
Butter	330 lb.
Flour	29 sacks
Graham flour	50 lb.
Corn meal	2½ sacks
Coffee	322 lb.
Potatoes	10 sacks
Carrots	200 lb.
Turnips	100 lb.
Cabbage	200 lb.
Onions	248 lb.
Parsnips	100 lb.
Apples	600 lb.
Salt	105 lb.
Dried peaches	30 lb.
Dried apples	65 lb.
Dried apricots	50 lb.
Dried prunes	100 lb.
Raisins	150 lbs.
Condensed milk	23 cases
Canned corn	3 cases
Canned tomatoes	5 cases
Canned peas	5 cases
Canned peaches	1 case
Canned pears	1 case
Canned pumpkin	1 case
Canned oysters	1 case
Maple syrup	3 cases
Crackers	4 cases
Macaroni	3 cases
Cheese	77 lb.
Sugar	9 sacks
Oatmeal	3 sacks
Beans	1½ sacks
Molasses	2 gal.
Jelly	3 buckets
Vinegar	6 gal.
Baking powder	8 (large) cans
Pickles	1 keg
Lard	25 lb.
Catsup	1 gal.
Tea	30 lb.
Chocolate	5 lb.
Cocoanut	6 lb.
Soda	2 lb.
Yeast foam	10 pkg.
Cornstarch	6 pkg.
Chowchow	8 qt.
Pepper sauce	2 bot.
Currants	9 pkg.
Hominy	20 lb.
Matches	½ case
G. S. soap	1 case
Tar soap	1 case
Ivory soap	1 case

The isolation of the camp made the cost of these supplies high and the thirty-mile wagon haul was expensive. The total payroll deductions for board were $2318 ($1 per man per day) and just about equaled the cost of running the boarding house, paying for all supplies and the cook's wages.

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Rapid drilling by hand is not accomplished by use of heavy hammers and forceful blows, but by hammers of proper size handled by men who know how to strike the blow that will cause the drill to cut and keep the bottom of the hole clear so that the drill is working on solid rock and not on a lot of loose fragments. This is an art, and is only learned by experience.

LEACHING APPLIED TO COPPER ORE* (XXII)

ROASTING PAEPARATORY TO LIXIVITATION.

By W. L. AUSTIN.†

Most solvents ordinarily employed for extracting copper from its ore attack the metal in its oxidized form more readily than when it is combined with sulphur. This is because oxidation must take place antecedent to leaching when, for instance, such reagents as sulphuric acid, ferric sulphate, and sulphurous acid are used in the lixiviation of a sulphide ore. It is obvious that if the solvent finds the metal present in oxide form, there is less work to do than when it must first be oxidized before going into solution. In leaching with sulphuric acid it is necessary that copper sulphides should have been previously oxidized, otherwise, with the weak solutions employed the metal is not satisfactorily extracted. If ferric sulphate is used as lixiviant, it acts both as an oxidizer and solvent, first oxidizing the copper sulphides and then bringing them into solution. When chlorine is the active agent in the lixiviant the copper sulphides are also attacked and dissolved, the reactions being materially assisted in the cases of some chlorine lixiviants by the oxidizing character of the salts present. Hypochlorous acid, and hypochlorous salts, are such oxidizers.

In considering the lixiviation of a given ore it therefore becomes of importance to decide whether oxidation of the copper constituents shall be effected by a preliminary fire treatment, or through the medium of chemical reagents: the relative expense incurred in carrying out the respective methods will naturally decide the issue. Instances may occur in which it will be cheaper to oxidize with the help of ferric or hypochlorous salts, but in most cases where oxidation is essential it will be found more economical to resort to roasting.

Oxidizing the copper content of an ore is not the only reason for roasting before leaching is undertaken: this treatment has a further beneficial effect, in that, by heating, the material is rendered more accessible to the solution. This is especially marked in the case of ore inclined to slime. It sometimes happens that ore which previous to roasting was almost impervious to solutions, is rendered quite leachable by light roasting—the water of hydration is driven off. With ore containing carbonates and sulphides, carbonic acid and sulphur are expelled by heating, and the mass is thereby rendered porous and absorbs solution.

Light heating with some classes of ore is said to effect a rearrangement of the molecules, and lays the copper more open to attack. For instance, Froelich (Imperial German patent No. 180,307 of 1902) has shown that chalcopyrite can be made amenable to leaching when it is heated for a short time above 200° C. without admission of air. By this treatment one-fourth of the sulphur content is said to distil off, and the color changes from blue-black to dark-brown. No copper oxide is said to form. Froelich represents the probable transformations by following formulae. $2CuFeS_2=Cu_2Fe_2S_3+S$.; $Cu_2Fe_2S_3=Cu_2S+2FeS$. A method of roasting which recovers part of the sulphur by distillation, produces no sulphur dioxide, and transforms chalcopyrite into a leachable product, certainly possesses the appearance of merit in these days of "smoke farmers."

Roasting copper ore for lixiviation, and roasting the same ore for smelting, are two distinct problems. In the latter instance the operation is carried only so far that sufficient sulphur shall be left in the roasted product to provide for a suitable matte-fall in the subsequent smelting: it is immaterial how the components of the roasting-charge rearrange themselves during treatment. On the otherhand, if the ore is to be leached it makes a very great difference in what combinations the copper, iron, etc., issue from the furnace, and the temperature at which the roasting is done has to be carefully watched. Failure to observe necessary precautions has been the cause of a number of disappointments in leaching undertakings.

ROASTING CHALCOPYRITE.

Copper occurs associated with other elements in the various mineralized forms which the hydrometallurgist is called upon to treat. Among the simplest of these are the carbonates and natural sulphates. The metal is also found in quantity combined with silica as chrysocolla, and as oxides; but by far the most common cupriferous minerals are the sulphides—chalcopyrite and chalcocite. It has been stated that copper is mineralized as chalcopyrite in two-thirds of all cupriferous ore treated.

The components of chalcopyrite are firmly combined, and authorities do not agree as to the grouping of the individual elements—but this is of minor importance. The essential fact is that the combination is very difficult to break up, as many metallurgists have from time to time reported who have tried to lixiviate raw chalcopyritic ore with solvents commercially available. Some form of preliminary oxidizing treatment has always been found necessary—viz., fine roasting, or chemical oxidation. Of these different methods, roasting is the one to which recourse is generally had.

The progressive stages of oxidation through which the pulp passes during treatment in an oxidizing furnace, are explained in text-books and need not be repeated here. What concerns the hydrometallurgist most are the forms in which copper and iron are combined with other elements in the final products. If roasting is conducted at too high a heat, ferric oxide combines with cupric oxide to form a ferrite (CuO,Fe_2O_3) which is insoluble in most dilute lixiviants. This ferrite is produced with extraordinary ease even in the wet way. Ignited, black cupric oxide rapidly decomposes ferric chloride solution, producing a brownish-yellow ferrite precipitate (Kohlmeyer in "Metallurgie" 1910 page 297). If caustic potash is cautiously added to a solution containing equivalent amounts of ferric chloride and copper sulphate (or cupric chloride), so that no copper remains in the liquid, a voluminous dirty brown precipitate comes down. After ignition this precipitate appears as a clove-colored ferrite, free from cuprous oxide.

In roasting chalcopyrite the formation of copper ferrite is supposed to be brought about as indicated in the following formula:

$Cu_2S, Fe_2S + 13\,O = (CuO)_2, Fe_2O_3 + 4SO_2$.

Thomas ("Metallurgie" 1904, pages 8, 39, and 59) proved experimentally that in the commercial lixiviation of chalcopyritic ore with ferric sulphate it is necessary to so conduct the roasting that sulpho-ferrite (chalcopyrite) shall be decomposed without forming oxy-ferrite. He also found that all copper ferrites resist the action of ferric sulphate solutions.

In addition to the formation of copper ferrites in roasting cupriferous ore, combinations of copper oxide with silica are also to be guarded against. If the temperature in the roasting furnace is

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sufficiently high, fusible copper silicates form, coating the cupriferous minerals and protecting them from the action of solvents in subsequent leaching operations. In roasting Anaconda slimes (for analysis see Mines & Methods, 1912, page 556), Hollis and associates (Bulletin of the Colorado School of Mines, Vol. IV, page 113) found that when a batch was roasted at red heat in an assay muffle until all sulphur had been given off, the copper was insoluble either in dilute or concentrated sulphuric acid, or in ammonia. This fact was explained by the assumption that the copper was either converted altogether into silicate, or that the fine particles were covered by a film of silicate. Hunt (Transactions of A. I. of M. Es., Vol. X, page 18), found that in roasting sulphide ore, in addition to soluble cupric sulphate, the pulp contained insoluble oxides of copper, and a small portion of a cuprous compound, which though insoluble in water was dissolved by a solution of hot, strong NaCl, and was thought to be a cuprous sulphate or sulphite.

Thomas showed ("Metallurgie," 1909, page 474) that when a chalcopyritic ore is roasted at a very low temperature, a product is obtained in which copper is partly in form of sulphate, partly as free oxide, and partly as undecomposed sulphide, but free from FeS. A roasted product of this description was said to leach easily. On the otherhand, Kerl states that undecomposed sulphides in roasted ore are not attacked by dilute acids.

TEMPERATURES IN ROASTING.

When making a sulphating roast, the temperature of the furnace is of the greatest importance. It should be controlled with the help of an electric pyrometer, and must be restrained within prescribed limits. It is well to note the following: at 100°C. the last mechanically associated water evaporates. At 230° a part of the sulphur of the pyrites and chalcopyrite escapes. A yellowish-grey copper ore (20 percent copper) becomes darker: at 260° it is for the most part dark-brown with faintly shimmering scales, some brown in color, others displaying iridescence. At 340°C. the characteristic odor of sulphur dioxide may be discerned, and at 400° the roasting is in full action. After that the temperature must be very carefully watched to prevent undue rise.

Another writes states that sulphur is separated from copper sulphide, and begins to burn, at 325°C.: anhydrous ferrous sulphate is decomposed at 590°: and copper sulphate begins to decompose at 653°, producing a basic, yellow sulphate of the composition $CuOCuSO_4$. At 702°C. this basic sulphate begins to separate into cupric oxide and SO. Zinc sulphate is decomposed at 700°C.: lead sulphate at above 1000°.

The formation of iron and copper sulphates takes place at about the same temperature, but more copper-sulphate is formed than iron-sulphate at corresponding degree of heat.

In treating a certain concentrate, it was roasted for several hours at about 450° to 480°C. to produce copper sulphate. After the copper sulphate was formed, the temperature was increased to change iron sulphate into ferric oxide. There was no danger of destroying the copper sulphate already formed, provided the heat was not permitted to exceed 600°C. During the latter hours of the roast the temperature was raised to about 560°, and in this manner the decomposition of iron sulphate was effected to a considerable extent, which was of importance in the following leaching, for thereby an excess of iron was avoided in the solution.

Laboratory experiments made at the Colorado School of Mines for the purpose of ascertaining the best temperatures for roasting the Anaconda slimes previously alluded to, so as to produce the largest amount of copper sulphate, are interesting. These tests were carried out in a gasoline assay-muffle, at a temperature between a dull-red and a bright-red. Roasting dishes were used, and stirring was done by hand at intervals of about five minutes. In the first series of tests the roasting was of short duration, and temperatures were high.

No. of Test	Time Min.	Temp. C.	Percent Copper Extracted from Roasted Pulp by Water	2 H_2SO_4 Sol.	10 H_2SO_4 So
1	3	640	6.2	27.5	38.6
2	5	"	16.8	43.2	53.3
3	7	"	20.7	46.5	62.3
4	9	"	24.7	57.2	69.6
5	11	"	20.2	62.8	70.1
6	13	"	17.4	65.1	69.0
7	15	"	20.2	63.4	72.3
8	20	"	....	16.8	18.5

SULPHATES DECOMPOSED BY PROLONGED HEATING.

In the above tests it will be noticed that the best extraction with water was achieved after the pulp had been roasted nine minutes; the best with two percent sulphuric acid solution after 13 minutes; and the best with ten percent solution after 15 minutes. This shows that the sulphatizing of the copper was very rapid, and also that the sulphates were even more quickly destroyed. After twenty minutes roasting there was practically no copper sulphate remaining in the pulp, but there was still some copper oxide left which had not gone into insoluble combination with other elements, and could therefore be leached with strong acid solution. The temperature given (640°C.) was clearly too high for sulphatizing, because in none of the tests was the copper brought into condition for profitable extraction.

The next series of tests was made at a lower roasting temperature—just below a dull-red heat, presumed to be 520°C. The results are given in the following table:

No. of Test	Time Minutes	Temperature C	Percent copper extracted from roasted pulp by Water	10 H_2SO_4 solution
9	15	520	43.5	87.9
10	30	"	55.2	92.8

The effect of the reduction in temperature is marked; but that the muffle was still too hot to produce the best results was clearly shown in the next tests, which were made without any visible color at all. It should be remarked that in lixiviating the roasted pulps 100 cu. cm. of solution was used in each case—the weight of the raw slimes was ten grams in each test.

No. of Test	Time Minutes	Temperature C	Percent copper extracted from roasted pulp by Water	10 H_2SO_4 solution
11	15	450	61.4	99.1
12	45	"	64.6	99.6

At this temperature the molecular construction of the chalcopyrite was broken up so that a ten percent sulphuric acid solution could attack the copper; but either the heat was insufficient, or the time too short, to convert all the metal into sulphate soluble in water alone.

In none of the above tests was temperature accurately determined. To remedy this defect a sheet-iron drying oven, with two shelves, was fitted with a high-temperature thermometer. A long series of experiments was carried out with this apparatus, but the temperature could not be raised above 270° to 280°C. on the lower shelf. It was found, however, that by roasting six hours at 282°C., 94.6 percent of the copper content of the roasted pulp could be extracted with a ten percent sulphuric acid solution. This is further evidence that the molecular constitution of chalcopyrite may be broken up at a comparatively low temperature, and the copper content rendered leachable with sulphuric acid.

Another series of experiments was then carried out in the same muffle as at first used, with the difference that Le Chatelier's electric pyrometer was employed to determine the temperatures.

No. of Test	Time, Minutes	Temperature C	Percent copper extracted from roasted pulp by 10 H_2SO_4 solution.
14	75	180	86.6
15	"	"	91.1
16	135	450	85.1
17	150	490	87.9
18	120	440	95.5
19	45	"	96.0
20	30	320	76.3
21	60	"	76.3
22	45	"	85.3
23	90	"	90.2
24	45	360	85.3
25	60	"	91.8

EFFECT OF THICK ORE-BEDS IN ROASTING.

In these last tests it is interesting to note that No. 19 gave 96 percent extraction after 45 minutes roast at 440°C., and No. 25, 92 percent after 60 minutes at 360°. The conclusion reached by the Colorado experimenters was, that the best temperature for sulphatizing the Anaconda slimes tested, lay between 400° and 470°C., and that 45 minutes roasting sufficed. Some larger batches of slimes, roasted for the purpose of making leaching and electrolytic tests, gave results which indicated that 45 minutes was not sufficient time when a thicker ore-bed was used. Whereas, the small tests gave 91 percent extraction with ten percent sulphuric acid solution, only 76 to 79 percent was extracted from the larger ones.

Further data relative to temperature in roasting ore for leaching purposes will be given in future articles; but some experiments made by Vondracek (Oesterr. Bergh. 1906, page 437) with a mixture of chalcopyrite, argentite and quartz, is interesting in connection with what has already been stated. The experiments were carried out in small dishes while passing a current of air over the pulp. Each dish was roasted separately and the gases emanating from the next following dish were allowed to pass over the preceding one. Each roast was then treated with an equal quanity of water, to dissolve the soluble salts. The following table gives the percentages of the different metals contained in the original ore which were brought into solution.

Lixivium from experiment No.	Temperature of roast	Percentages going into solution		
		Silver	Copper	Iron
1	750°C.	31.3	17.5	Trace
2	650	84.4	83.4	1.2
3	500	90.6	83.0	1.0
4	400	87.5	....	5.1
5	300	96.9	95.9	6.1
6	200	93.8	88.4	10.7

The large percentage of the silver content of the pulp brought into solution is noteworthy.

QUANTITY OF AIR ADMITTED TO ROASTING FURNACE.

In roasting sulphide ore an excessive supply of oxygen may have deleterious results, for when sulphides have been heated to a certain point, the elements of which they are composed unite with the oxygen of the air, and the heat liberated may exceed that desired for the operation. In this manner it may transpire that particles of ore become fused, a condition which is, of course, very detrimental for subsequent leaching. For this reason it is desirable to always have the admission of air to the furnace under control, and to watch the pyrometer carefully at certain critical points in the firing. As soon as combustion of the sulphides starts, the air supply should be shut off temporarily. However, in carrying out a sulphatizing roast properly, it is essential to have a surplus of air in the furnace after danger of too free combustion of the sulphides has passed. It is thought probable that the formation of sulphates is assisted by the catalytic action of certain metallic oxides, and if sufficient oxygen is present, sulphur dioxide formed in one part of the furnace may be further oxidized, and in this state can unite with cupric oxide in another part. Sulphur dioxide and oxygen act upon one another very slowly when brought simply into contact, but there is quick action in the presence of a catalizer such as ferric oxide. The formation of sulphur trioxide should be assisted by supplying the oxygen necessary to raise sulphur dioxide to the higher degree of oxidation.

The admission of too much air to a roasting furnace may have the further effect of cooling the partially roasted charge below the point where the proper chemical reactions can take place. This is brought about by heating the excess of air at the expense of the furnace walls and charge. Therefore, in designing a furnace the proper proportions with relation to the work to be performed, must be carefully considered, and it is easy to see that a furnace admirably adapted to one class of roasting may be disappointing when called upon to perform anotner.

Should insufficient air be present in the gases passing over a roasting charge, the sulphur dioxide can reach proportions where it smothers the combustion. Sulphur dioxide is one of the most efficient fire-extinguishers known, and has been employed for that purpose.

DEGREE OF SULPHATIZATION OBTAINED.

It was shown in the foregoing that a high percentage of copper sulphatization can be obtained with proper roasting, even on a low-grade ore. It is obvious that when the constitution of an ore is such that a sulphatizing roast is possible this is the best method for adoption, because then the ore itself provides the leaching agent.

The richer an ore is in copper, the easier it has been found to bring a large percentage of the metal into solution. At one works where a 20-percent concentrate was leached, there was seldom less than 98 per cent of the copper rendered soluble in sulphuric acid. In the southern Tyrol concentrates were leached which analyzed 7.13 per cent copper. This material was roasted in a horizontal revolving drum so that from 95 to 96 per cent of the copper content was made soluble in sulphuric acid. Over 65 per cent of the copper was obtained in form of copper sulphate, soluble in acidulated water, with only a small quantity of soluble iron salts.

Other tests, made on low-grade pyrrhotite, showed that it was not difficult to obtain 97 per cent of the copper content soluble in acidulated water, with twelve hours roasting at 480 deg. C.

The time required to produce sulphatization of copper in an ore depends upon the means adopted for bringing hot oxidizing gases into contact with the minerals to be acted upon. It stands to reason that it will require more time to oxidize a bed of ore several inches thick, lying on a horizontal hearth, than it will the same ore showered through an oxidizing atmosphere in a rotating furnace. For this reason furnaces rotating on a horizontal axis have often been used for the purpose; but even then it has not been found practical to sulphatize quickly.

TYPES OF ROASTING FURNACE.

The various styles of furnace available for making a sulphatizing roast may be divided into three classes. (1) mechanical furnaces with horizontal hearths; (2) rotating furnaces with horizontal axis; and (3) kilns. The first two types may be further separated into reverberatories and muffles. Reverberatories in which the ore is roasted by hand have for the most part gone out of use, as they are not economical to operate.

Muffle furnaces are preferred by some from the fact that the gases resulting from combustion of the fuel used in firing are not permitted to pass over the ore. There are other advantages in employing muffles for roasting ore that is to be leached—the temperature can be better controlled and is more uniform. There are also objections to this method. For instance, as heat must be transmitted through the walls of the muffle, material which is disposed to fuse is apt to agglomerate, especially on the floors of such furnaces, as the underlying portions are the first to receive the heat and are protected from oxidation by the overlying pulp.

According to Thomas ("Metallurgie," 1904,) who instituted a number of experiments looking to the sulphatization of chalcopyrite, ordinary mechanical roasters suffice for this purpose. They also permit the use of pulp ground to moderate degrees of fineness.

With regard to roasters having horizontal hearths, in the Engineering & Mining Journal of March 21st, 1908, page 615, it is stated that in roasting a batch several tons of ore containing about 18 per cent copper and 16 per cent sulphur, the Wedge multiple-hearth furnace was able to bring the pulp down to 1.3 per cent sulphur largely in form of sul-

phates) without the use of any extraneous fuel, notwithstanding the low sulphur content of the original ore. In roasting ore at Butte for treatment by Neill's leaching process, the sulphur content is said to have been reduced to 2 per cent by a Herreshof furnace.

As to roasters revolving on a horizontal axis, in heating chalcopyrite with exclusion of air, so as to break down its molecular structure in order that the contained copper might be extracted with solvents, Froelich recommends a revolving drum. In southern Tyrol, where leaching operations were carried on for two years, the sulphatizing roast was made in a horizontal revolving drum, externally heated.

Kilns were made use of at the Miedzianka plant, described in Mines & Methods for December, 1911, and at the Keystone mine near Globe, Arizona. In the first named instance the ore was pulverized and made into a paste with 5 per cent clay. This paste was molded into bricks which were dried by the waste gases from the kiln. The dried bricks were charged into the kiln and roasted, with careful regulation of the draft. In this manner the copper sulphide was said to be wholly oxidized, and was leachable in a solution carrying 7 per cent sulphuric acid.

At Agordo, in Italy, fine pyrites were made up into cakes with an iron sulphate solution. These cakes were dried and roasted—presumably in heaps—very little wood being required. At Freiberg, in Germany, the same process was tried; but the cakes broke up, owing, probably, to small lime content of the material used.

It is interesting to note in this connection the effect of producer gas in roasting. At a works where pyrites were used for generating sulphuretted hydrogen by passing producer-gas over them, it was found that the roasted material was brought into a condition for weathering to sulphate much more readily than when the same pyrites were roasted in heaps.

The unit of weight known as the carat, used for weighing precious stones, is equal to 3 1-5 grains troy. The term carat is also used to express the fineness of gold, in which connection it means one-twenty-fourth part. Pure gold is 24 carats fine. Twelve-carat gold is 12 twenty-fourths pure gold.

Shoveling contests at the Continental zinc mine, at Joplin, resulted in the winner filling 235 cars, each holding 2700 lb., in five and a half days, equal to 317 tons. Eighteen cents per car is paid for this work.

TIN DEPOSITS IN ALASKA

The United States uses between 40 and 50 per cent of the world's production of tin, yet American manufacturers are almost wholly dependent upon foreign mines for their supply of raw material. Alaska may make up a very small part of this deficiency, according to a report on the "Tin Resources of Alaska by Frank L. Hess, recently published as Bulletin 520-B by the United States Geological Survey.

Tin was first discovered in Alaska on Buhner Creek, Seward Peninsula, in 1900. The next year stream tin was found on Buck Creek, which is separated from Buhner Creek by a low divide In 1903 tin oxide was found on Cassiterite Creek, a tributary of Lost River, 20 miles from Buck Creek and about 100 miles northwest of Nome. Later discoveries of stream tin were made at several other places in the territory.

Of the tin placers none have shown much importance except those of Buck Creek. In the gravel of the creek bed the content of stream tin carrying about 65 per cent metallic tin has been found to be as high as 400 pounds per cubic yard in rich spots, though the average is under 30 pounds. In figures furnished the Geological Survey, the gold in the gravels has been estimated at 40 cents per cubic yard, at $60 per ton of stream tin, and at other amounts. Nuggets of gold valued at $20 or more have been found. When compared with the Australian and Malayan gravels, where the "black tin" content is in many places from 1½ to 5 pounds per cubic yard, the gravels of Buck Creek appear very rich, but the climate makes the conditions hard for placer working. The season is short, little or nothing can be done before June 15, and the freeze-up is apt to come by September 15. There are many storms, with cold, heavy rains, but, on the other hand, the country is very healthful. A dredge working in this district last year from September 10 to October 15 saved 92 tons of stream tin averaging 66 per cent tin, or an equivalent of 101 tons carrying 60 per cent tin, and sold for $52,000.

DRILL STEEL TEMPERING

In the Joplin district a unique method of tempering the drill steel is used. It is a modification of the plunging method that retains all the advantages of plunging while there seems to be little trouble from temper checking and few drill bits break off at the shank.

The method consists of using old worn-out jig grates to form a shelf to support the drill steel in the tempering tank, which is a rectangular box about 12 in. wide, 4 ft. long and 12 in. deep. This shelf is arranged so that there is from ¾ to 1¼ in. of water on top of the grates. In a few instances more than this depth of water is used over the grates, but that is not good practice as it is apt to result in breaking off of the steel at the water line. The shelf must be made of iron, for if wood were used, the hot drills would burn into the wood enough so that the bit would not be properly cooled, and a soft drill would result. A greater depth of water is used over the grates

with machine tempering than with hand work owing to the fact that it is difficult to keep the water as cool with the faster sharpening done with the machines, as when the work is done by hand.

There is a continuous feed of water going to the tank, and the amount is regulated so that by the time a drill has been put into the tank the temperature of the water is approximately at the temperature of the inflowing water. Of course the depth of the water on the grates is regulated by the overflow, which is generally a 1-in. pipe that takes the water clear out of the blacksmith shop before it discharges it.

In the presence of United States army officials and some other engineers, Marquis Roberto Imperiali recently exhibited near New York a new explosive, of which he is the inventor. According to a statement from the daily press, Imperiali pounded the substance between heavy hammers, melted it to a vapor in a chafing dish and heated it gradually to 400 degrees C. without causing an explosion. Afterwards, by the use of a fulminating mercury cap, he blew a 25-ton granite boulder into small pieces with 800 grams of the material. The inventor declares that only the mercury cap will cause the discharge and he asserts that the force attained is superior to that of dynamite.

Commenting on the "sootability" of Pittsburg, Graphite says that 40 per cent of the dust in that city is soot, and that its citizens wear plain black soots, with stripes when it rains.

In brazing cast iron, clean the parts to be joined, heat to a bright red, and apply a flux made by mixing the following ingredients: Boric acid, 1 lb.; potassium chloride, pulverized, 4 oz.; and 3 oz. iron carbonate.

Way Things Look at Tonopah Today

By AL. H. MARTIN.

The new era of Tonopah dates from December, 1909. In that month the Tonopah Development Company demonstrated the persistent character of the Tonopah deposits. Previous to this strike it was generally thought the orebodies were comparatively shallow deposits, and that the ore limits of the camp had been fairly well established. But with the Belmont discovery came the knowledge that the richest ore occurred in what had been considered almost barren ground. Since 1909 the development of Tonopah has progressed rapidly until today the camp stands first among Nevada's producing mineral towns. The total production of Tonopah mines from the initial discovery to present date approximates $54,000,000. Of this, the Tonopah Mining Company yielded about $30,500,000, and Tonopah Belmont $11,500,000. Montana Tonopah and Tonopah Extension represents the major portion of the remainder, with West End and MacNamara each recording about $1,500,000. Tonopah Midway has produced in excess of $1,273,000, while Jim Butler and North Star have contributed to the total. The remarkable factor in this mammoth yield has been the large profits disbursed. Approximately one-quarter of the entire porduction has been paid to stockholders in the form of dividends—a record practically unparalled by any other district of modern times. Total dividends paid by Tonopah companies follows:

Tonopah Mining	$ 9,250,000
Tonopah Belmont	3,218,000
Montana Tonopah	430,000
Tonopah Extension	323,586
Tonopah Midway	250,000
MacNamara	50,000
Total	$13 521,586

The history of Tonopah has been a record of daring ventures, superb faith and sustained courage. The camp has had its periods of elation and despondency—its eras of sunshine and shadow. From the first its founders were forced to battle with the prejudice always attending the development of a new field, while nature seemed to take savage delight in imposing apparently insurmountable obstacles in the path of the sturdy pioneers. The early prospectors were forced to contend with desert heat in summer and searching cold of winter; with water a precious commodity and transportation facilities nil. Pitched in the midst of the sterile desert only the wonderful richness of the surface deposits and the indomitable spirit of its founders forced the camp to the attention of the world. It was in May, 1900, that Jim Butler discovered the first ore in Tonopah, but it was not until the following August that he located the claim which subsequently became a portion of the rich holdings of the Tonopah Mining company.

The story of wonderfully rich ore brought to the outside world by Butler excited the interest of prospectors, and these hawks of the hills and gulches flocked by burro and pack train to the new El Dorado. Butler and associates leased portions of their holdings and the large tonnage of rich ore shipped out started the historic rush which evolved a new Nevada. Capital speedily became interested, investigated and purchased. In June, 1901, the Tonopah Mining Company was formed and the eight original claims held by Butler acquired for $336,000. Only $50,000 was paid in cash. The sale stipulated that the leasers were to be permitted to continue operations until December 31st, of the year, and out of the royalties paid by them to the company came the balance of the purchase price. Up to January, 1902, it is estimated the claims yielded about $3,000,000 from the Mizpah, Silver Top, Burro and Valley View veins. Despite the excellent record of the property is was with extreme difficulty that stock in the new Tonopah Mining Company was marketed. Mining was in such ill repute, and Nevada was so generally regarded as but the shadow of departed glory, that anything savoring of the industry or state was deemed fit subject for ridicule. The officers eventually managed to sell an issue of 350,000 shares of preferred, interest-bearing stock at the par value figure of $1 by allowing a bonus of two shares of ordinary stock with each perferred share taken. The preferred issue was retired with interest in February, 1905. Thus many obtained for absolutely nothing stock that has paid magnificent dividends and is still quoted around $7 per share. With the inauguration of vigorous and successful mining by this company, the active history of Tonopah commenced. Other companies were rapidly formed and activities, often badly directed, incepted throughout the district.

Camp of Tonopah, Nevada, as it Looks Today.

In 1903 rich strikes in the Montana Tonopah estate added fuel to the fires of interest, and the wavering blaze was fanned into a mighty flame by a series of important finds in the West End, Tonopah Extension, Belmont, Midway, North Star and other prospects. A mad demand for stocks developed and soon prospects were held at values that would have been inflated prices for rich producing mines. As the surface high-grade shoots were exhausted and the less spectacular milling ore took their places the speculators wavered. Then came the inevitable reaction. Paper fortunes were lost overnight and the demoralized stockholders bitterly denounced Tonopah as the criminal chimera of unscrupulous promoters. In the first flush of its prosperity the camp was stricken by a malady fabricated by stock gamblers and irresponsible brokers. The 1907 panic quenched the hopes of many brave souls who had maintained sublime faith in the district's future, and for months it seemed that the camp which had shone so brilliantly in the first years of the decade was doomed to the murky abyss of oblivion ,before the cycle had closed. The Tonopah Mining company had continued its steady disbursements of princely dividends, but developments in the deep levels had been unsatisfactory, and the end of the giant property was gloomily prophesied by many who had once been its boldest advocates.

Belmont Mine, Tonopah, Nevada.

CHANGE FOR BETTER IN 1909.

This state of practical inertia and gloom prevailed until the close of 1909. Then came the great Belmont strike. The Belmont mine, hitherto regarded as a worthless consumer of good coin, instantly leaped into world prominence. The strike was made near the 1000-foot point and the theory that the Tonopah veins were not persistent was instantly disproved. From this time Tonopah entered upon a new cycle of progress and achievement. Other companies gathered courage; additional funds were subscribed, and deep mining became the slogan of the hour. At present there are twenty-two shafts in the camp that are down over 600 feet, while eight have passed the 1000-foot level. Total area of underground workings aggregates over 400,000 feet, or in excess of sixty-nine miles. Millions of tons of commercial ore are demonstrated and developments are constantly augmenting the source of future revenues. Including the old Belmont mill at Millers, the reduction plants of the district embraces 320 stamps. The Tonopah Mining company's Millers plant contains 100 stamps, and the new Belmont mill has sixty. The Montana has forty; the Tonopah Extension, thirty; the West End, twenty, and the NacNamara ten stamps, respectively. The Millers plant of the Belmont embraces sixty stamps, a portion of which is operating on ore from the Jim Butler. Recent figures indicate the mills effect an average recovery of 92½ per cent of assay values.

BELMONT PROVEN UP DEEP.

Paramount attention naturally attaches to the Belmont mine, the property which demonstrated the presence of huge deposits of commercial ore at depth and incepted the new Tonopah. The mine has been developed to a depth of 1446 feet by the Belmont shaft, and it is stated deeper developments will be inaugurated in the near future. In addition to the main Belmont vein, the Shaft and Lillie Bell veins show excellent character in the deep levels. The Belmont vein ranges around twenty-five feet wide in the lower workings and occurs in trachyte, or early andesite. The mine lies in the eastern portion of the camp, with about 55,000 feet of underground developments. An immense tonnage has been developed, and the conditions were deemed so satisfactory that over a year ago the management determined on the erection of the most modern mill in the district. Not only was this step influenced by the values encountered, but on the superior strength of the ore-bodies as increased depth was gained.

The building of the plant was authorized in June, 1911, and preliminary work on the site started the following month. On July 25, 1912, the plant went into action. It has a minimum rated capacity of 165,000 tons per annum and is expected to result in saving $2.50 per ton over the costs attending shipments and treatment at the old Millers plant. After reduction in rock-crushers the ore passes to the mill bins. The passing ore is weighed by an electric weighing machine. Challenge feeders gather the crushed ore and delivers to sixty 1250-pound stamps. From the stamps the product passes to eight Duplex Dorr classifiers. Subsequent treatment includes passage through eight 5x18 tube-mills, sixteen Wilfley tables, Dorr thickeners, Pachuca agitators and cyanide plant. The Merrill system of zinc precipitation is employed. The mill was designed to treat all kinds of Belmont ore, eliminating necessity of shipments to smelters, and facilitating milling of lower grade ores that were not deemed profitable to handle at the old Millers plant.

The directors have consistently endeavored to increase percentage of mill recovery and reduce operating costs, a policy that has been attended with marked success. In 1909 milling costs averaged about $4.37 per ton, while mining costs aggregated over $7.81. In 1912 mining costs had been reduced to $4.85 per ton, and the milling expense cut down to approximately $3.36 per ton. This record was made with the old Millers plant. Thus in four years the Belmont management effected a saving over first costs of $3.97 per ton of ore treated. The figures strikingly illustrate the remarkable progress that has been made in reducing costs in the Tonopah district, and it is probable the next three or four years will record further impressive advances.

TONOPAH MINING'S RECORD.

The extensive holdings of the Tonopah Mining Company have been developed by about 139,500 feet of underground workings, and 7,276 feet of core drilling. The Mizpah shaft is down 1500 feet, making it the deepest in the district. The Silver Top shaft is down 740 feet and the

Red Plume 700. The Sand Grass shaft is down over 500 feet and will be sent deeper. The Desert Queen shaft, controlled by the Tonopah Mining, but formerly used by the Belmont, has a depth of 1127 feet.

The Tonopah Mining produces its ore from the 700 and upper levels. The last annual report placed the available tonnage at 304,824, February 1, 1912. This was valued at $5,237,974. Mining costs for 1911 averaged $3 71 per ton, while milling costs amounted to $2.74. Marketing mill products, freight on ore, and metal losses in milling brought the total expense to $9.63 per ton. Despite the heavy costs the ore yielded a profit of $10.34 per ton. The 100-stamp Millers plant of this company has been so often described, and the method of treatment is so widely known, that details are here dispensed with.

Besides developing the Mizpah mines to a high state of efficiency, the Tonopah Mining Company has been particularly active in endeavors to increase its sphere of operations. It has been long recognized that to prolong the profitable existence of the company other properties must be acquired, and the management is constantly searching for mines of merit. In the last annual report General Manager J. E. Spurr stated that offers of mines to the company averaged about fifty per month, but out of this large number only a few propositions were deemed worthy of investigation. Several properties are being considered and the success of the company at Tonopah may result in bringing prosperity to other districts.

EXTENSION PROMISES WELL.

The Tonopah Extension is one of the deepest mines in the camp. The Pittsburg shaft is down 1150 feet, and shaft No. 1 has attained a depth of 1050 feet. The Red Rock shaft as a depth of 700 feet. Deep developments in this property have been recently very encouraging, and the company has taken its place among the regular dividend disbursers. Like many other Tonopah mines, this property was formerly considered virtually worthless, but under the stimulus of skillful and energetic management has developed into an excellent mine. It is estimated a two years' reserve of ore is exposed, with steady developments more than keeping pace with production. The mill was one of the first to embody the lessons garnered from the operations of the older Tonopah and Belmont plants at Millers, and is an excellent type of the modern Tonopah reduction plant.

After reduction in a Kennedy crusher the ore is conveyed to the mill bins by a 16-inch belt-conveyor. Suspended Challenge feeders deliver to thirty 1050-pound stamps dropping ninety-eight times per minute. The stamps are arranged ten to a battery and five to a mortar, with each battery operated by a 30-hp. Westinghouse motor preforming 690 rev. per minute. From the stamps the pulp runs to Deister concentrators, where coarse concentrates are separated and removed, and the tailings passed to Dorr classifiers. From these the coarse material is received by two 5x18-inch trunnion tube-mills. These are equipped with El Oro lining. The tube-mill pulp and slime overflow of the Dorr tables flows to hydraulic classifiers where the coarse product is removed. The slimes pass to Callow cones and the thickened pulp goes to Deister slimers. After cyaniding the pulp is filtered by Blaisdell filters and the gold and silver precipitated by the usual zinc dust process. The Tonopah Extension boasts approximately 25,000 feet of underground developments.

The New Belmont Mill, Tonopah, Nevada.

SOME OF THE OTHERS.

Ranking among the highly productive and profitable mines of the camp is the Montana Tonopah. This property has been developed to a depth of 765 feet, with about 64,000 feet of underground development. The property has a recorded production of over $4,850,000, with a proven reserve calculated sufficient for over two year's operations. The mine was among the first to demonstrate its merit in the district, and has come in for particular interest during the last two years. The veins range from a few inches up to fifteen and sixteen feet in width, with values varying from high grade to medium milling quartz. As in many other Tonopah mines the veins are marked by considerable faulting, but as experience has been gained less difficulty is experienced in recovering the shoots. The shaft has three compartments and is equipped with a double-drum twin-cylinder 15x18-inch hoist, operated by compressed air and using double-deck cages. The ore is crushed in cyanide solution by forty 1050-pound stamps, and the product treated by Wilfley concentrators, Dorr classifiers and Frue vanners. From the lower concentrator floor the product passes to the cyanide plant. Final treatment is accomplished by means of Butters filters and Merrill precipitating presses.

Among the other principal mines of Tonopah, the West End, Jim Butler, Midway and MacNamara have been most largely developed. The Jim Butler has a developed area of about 25,000 feet, with seven shafts on the estate. Of these the Gold Hill is down 800 feet, while the Wandering Boy has attained a depth of 700. The Stone Cabin is down 625 feet and the Tonopah City 575. The mine has produced $315,610 and the company recently arranged for the treatment of its ore at the old Belmont mill. The Midway shaft is down 850 feet and the underground workings of the Midway mines approximates 36,000 feet. This property has produced nearly $1,275,000, with fair reserves exposed. The West End embraces three shafts, of which the deepest is the 800-foot No. 1. Underground developments approximate 25,000 feet, and the property has a recorded production of over $1,300,000. The twenty-stamp mill handles about 3100 tons of ore per month. The MacNamara developments approximate 13,500 feet. The property is equipped with a ten-stamp mill and has yielded about $1,600,000.

Two properties that are attracting considerable attention at this time are the Tonopah Merger and Halifax. In the former the intersection of a rich shoot at a depth of 940 feet recently caused intense excitement, not only because of

its seeming richness, but also because it extended the demonstrated ore zone for a total length of about 9000 feet and a width of 3600 feet. The Merger shaft is going down to the 1075-foot point. With the culmination of this work extensive laternal developments will be undertaken. The Halifax shaft is down 1400 feet and is planned to develop a large area of territory considered practically proven by the Belmont developments. Several other properties are receiving attention, noticeably the North Star, Rescue Eula, Tonopah 76, Monarch-Pittsburg Extension, Gypsy Queen, Buckeye-Belmont and two or three others.

In the recent progress of Tonopah the fairly high price of silver has played an important role. Silver represents about two-thirds of the precious metal content of Tonopah ores, and every advance in price of the white metal means a corresponding profit. Tonopah is now producing about 10,000 tons of ore per week, having an average approximate value of $270,000. With additional shipments from the Jim Butler this record will be surpassed, while other properties appear on the eve of adding their contributions to the grand total.

LAWS GOVERNING EMPLOYERS' LIABILITY

By JAS. O. CLIFFORD.*

There are few subjects provocative of greater discussion than the Employers' Liability for Accidents to Employes, which is evidenced by voluminous literature on the subect. It is manifestly impossible here to do other than to present a few important constructions of the laws relative thereto, derived from various decisions given by the supreme States' Courts, and by the supreme National Court.

In the absence of legislative enactments the relations existing between empolyers of labor and their employes, and the reciprocal duties, rights, and obligations growing out of those relations, are governed by the common law.

The English Common Law is the basis of our doctrine of Employers' Liability, but this doctrine is constantly undergoing change, both by the rulings of the States' and the National Courts, and by the enactment of numerous statutes passed with a view to a more exact definition of the rights of the employe, or to some amelioration of his condition in other respects.

The purpose of the following statements is merely to state the principles and rules of the Common Law. Of course, the reader must bear in mind that, where they have been modified or changed by legislative enactments, any rule or principle of the Common Law conflicting with a statute which has not been declared invalid or unconstitutional by the supreme National Court, it is either modified or entirely changed by the statute, in which case the statute instead of the Common Law governs.

The principles of the Common Law are differently interpreted in the various State jurisdictions, indicating merely a locally recognized view which is not in accord with the generally accepted construction of the law. The results of these circumstances have been that the statutes, where enacted, range in form and effect from a mere restatement of the Common Law, to an abrogation of it in some more or less inclusive degree.

The great volume of litigation on the subject has not affected results of a conclusive character, due, perhaps to the fact that it is largely an effort to determine the boundaries between the risks assumed under the law by the injured employe, and the unlawful negligence of the employer in causing, or permitting, dangerous conditions to exist. The definitions of these factors often have not been accurately drawn, nor have those formed been so generally accepted as to secure uniformity. Again, the view formerly prevalent favored the entire assumption of the risk by the employe, while the gradual growth of the doctrine of the duty of his protection by the empolyer has given rise to a variety of decisions and statutory enactments, with the result that the existing body of law and practice in the United States is, in effect, largely of the nature of a compromise.

DEFINITIONS.

Employer.—One who employs; one who engages or keeps in service; one who uses or engages the services of another for pay. Construing the word according to the context it may include not only a master, but also a client, a farmer, a firm, a joint-stock association, a company, or a corporation, and the like. (1)

Employe.—One who works for an employer; a person working for salary or wages; a person employed; one who works for wages or salary or who is engaged in the service of another; one whose time and skill are occupied in the business of his employer; one who works for another for hire; a person hired to work for wages as the employer may direct, and so forth. (1)

The words employer and employee are legally synonymous with the words master and servant.

Relation.—The relation of employer and employee is created by contract, either expressed or implied, where both parties have the requisite legal qualifications for entering into a valid contract. (1)

The relation exists only where the person sought to be charged as employer and controls the other party to the contract of service, or espressly or tacitly assents to the rendition of the particular service by him. The employer must have the right to direct the action of the employe, and to either accept or reject his service. The relation does not cease so long as the employer retains his control, or right of control, over the methods and manner of doing the work, or the agencies by which it is effected. Furthermore the relation exists where the employe is employed, not by the employer directly, but by an employe in charge of a part of the employer's business, with authority to engage assistance therein.

Contractor of Service.—A contract of employment is one by which an employer engages an employe to do something for the benefit of the employer, or of a third person, for a sufficient consideration, either expressed or implied. Ordinarily, when an adult person solicits employment in a particular line of work, the solicitation carries with it an implied assertion that the one seeking employment is competent to perform the ordinary duties of the position sought; and it is an implied condition of every contract of service that the employe is competent to discharge the duties of his employment. (1)

Unless otherwise agreed, the wages of an employe must be paid in cash. The employer has no right to handle, or invest, or in any manner apply such wages, whether beneficial to the employe or not, but must pay them directly to him.

Labor Unions and Employers' Associations.—Everyone has the right to work, or to refuse to work, for whom and on what terms he pleases, or to refuse to deal with whom he pleases; and a number of persons, if they have no unlawful object in view, have the right to agree that they will not work for, or deal with certain persons or that they will not work under a fixed price or without certain conditions. This right of employes to refuse to work, either

* Mining and Metallurgical [illegible] Mills Bldg., El Paso, Texas.

singly or in combination except upon conditions and terms satisfactory to themselves, is balanced by the right of employers to refuse to engage the services of anyone for any reason they deem proper. In fact both employers and employes are entitled to exercise the fullest liberty in entering into contracts of service. (1)

EMPLOYERS' LIABILITY.

An employer is ordinarily liable in damages to his employe who sustains an injury through the employer's negligence. Such negligence may consist in the doing of something by the employer which, in the exercise of ordinary care and prudence, he ought not to have done, or in the omission of any duty or precaution which a prudent, careful man would, or ought to have taken.

The two principal factors of the problem are (1) the duty of the employer to provide his employes in the discharge of their duties with reasonably safe tools, appliances, and work-places; and (2) the assumption by the employe of the risk involved in the undertaking in which his contract of employment engages him.

The duty of the employer will first be considered, but it will be found impossible to discuss it without constantly bearing in mind the modifications that result from the existence of the complementary obligations resting on the employe.

DUTIES OF EMPLOYERS.

General.—The duties of an employer are that he is required to use due care for the safety of his employes while they are engaged in the performance of their work. This is assumed to include all reasonable means and precautions, the facts in each particular case being taken into consideration. If such provisions have been made as a reasonably prudent man would supply if he himself were exposed to the dangers of the employe's position, the employer will not be guilty of negligence. The supreme National Court rules, that in the case of corporations, they must exercise such caution and foresight as a corporation controlled by careful, prudent officers ought to exercise. The courts have, however, condemned any instructions tending to charge employers with a higher degree of care than that which may be defined as ordinary; and though the measure is not an absolute one, it is proportioned to the dangers to which the employe is exposed. In comparison with other employments mining and metallurgical work are, in themselves, unusually dangerous. In such cases (where unusual danger exists) ordinary care is advanced far beyond the requirements of less dangerous occupations.

Instrumentalities.—Important obligations of the employer are to supply tools and appliances which are reasonably safe for the intended use, and reasonably well adapted to perform the work in contemplation. Closely related is the duty to provide a safe place in which to work, although, from the many decisions rendered, the distinctions between place and appliances is not an easy one to draw.

Improvements.—The requirement in the way of improvements, or the adoption of new safety appliances, is governed largely by the usual procedure of those engaged in the same business. An employer is not bound to introduce the newest and safest appliances, but he cannot disregard all inventions for securing safety of his employes. The standard of the custom of prudent men, and the law of general usage, may compel the adoption of new devices by employers, the omission of which had not been previously considered as negligence.

The condition that an employer must safeguard his employes from exposure to unreasonable risks is subject to the general qualifications that one has the right to carry on a business which is itself dangerous, provided it does not incur liability to an employe who is capable of contracting and who knows the dangers attendant on employment in the circumstances. Briefly, the employer and employe have a right to exercise reasonable judgment and discretion in the conduct of their respective affairs.

While the doctrine does not permit the use of unreasonably dangerous appliances, nor those which are defective or obsolete, or so inferior that their adoption or retention would indicate negligence, the question is not one of comparatively safety, but reasonable safety. Consequently no fixed rule of liability is possible, each case being of necessity decided by its own merits.

Maintenance.—As in the case of furnishing safe and suitable appliances and work-places, the same care is required of the employer to maintain such appliances and work-places. If the dangers in such instances are obvious, the employe, continuing to work with a knowledge of the danger and without complaint, assumes the risk and can not recover for injuries sustained, nor will liability attach until the employer has, or could have, information of the defect requiring repair.

Customary Methods and Intended Use.—Liability attaches only where the injury is the result of the use of an appliance for the work and in the manner for which it was furnished. The practice indulged in by employes of riding belt-conveyors, mine ore-trains, ore-loaded mine cages, and other agents intended for specific uses, is subject to the action that the employe assumes the risk, and can not recover for injuries sustained. This rule is qualified by continued indugence of the practice with the employer's acquiescence. The adaption of an appliance to new uses by the employer or his representative qualifies the rule.

Closely connected with the foregoing is the rule that an employer is not liable to an employe for an injury incurred by a departure from the customary method of performing work, or by changing his place of employment to some other department, unless on instruction from a properly authorized representative.

WORKING FORCE.

Coemployes.—Various attempts have been made to lay down some rule or formula by which to determine what employes of a common employer may be said to be coemployes. While the following definitins are said to be faulty, they nevertheless give a fair idea as to whom have been determined by many courts to be coemployes, within the rule exempting employers from liability for the negligence of one of them resulting injuriously to another: (1) Persons are coemployes where they are engaged in the same common pursuit under the same control, derive authority and compensation from the same common source, and are egaged in the same general business—though it may be in different grades or departments of it—are coemployes who take the risks of each other's negligence. (1)

The principal limitations contended for on the general rule in regard to coemployes is that there is such an employe as a vice-principal who takes the place of the employer, and who is not a fellow employe with those beneath him; and there are many variations of the idea to the effect that every superior employe is a vice-principal as to those beneath him.

Whether one is acting as the representative of the employer, or merely as the fellow-employe with others employed by a common employer does not depend upon his rank or title, but upon the character of the duties he is performing at the time another employe is injured through his negligence. If at such time the offending employe was in the performance of a duty which the employer owed his employe he was not a coemploye with the one injured, but a vice-principal. The rule is fundamental that an employer can not rid himself of a duty he owes to his employes by delegating his authority to another and thus escape responsibility for neg-

ligence in the performance of such duty. If, however, at the time of injury the negligent employe was not engaged in the performance of a duty from the employer to the employe, but was discharging a duty which was due from the employe to the employer, he was a coemploye to the one injured, engaged in the same common business, and the employer would not be liable for the injuries sustained by reason of his negligence.

Duties Nondelegable.—The courts in general have held quite consistently to the view of the nondelegable quality of the duties enumerated, their rulings being that, as to employes, the employer can relieve himself only by performance. In some cases, however, it has been held that the appointment of an employe to the duty was a sufficient discharge of the obligation.

Incompetency of Coemployes.—If an employer knowingly employs or retains in his employment an incompetent employe, he is liable for an injury to his fellow-employe sustained through the incompetency of such coemploye. Of course, an employer does not warrant the competency of his employes, but he must use all ordinary care and diligence in their selection and retention. If he has not been negligent in selecting an employe and subsequently obtains knowledge of the employe's incompetency and still retains him, he is liable to all other employes for any injuries resulting from said incompetence. However, no employe is entitled to damages for any injuries resulting from said incompetence on the part of a coemploye when he knew of such incompetence and did not inform his employer of same. It must be considered, however, that neither incompetence nor unskillfulness will be presumed; they must be proved. The disqualifications of persons of suitable age may be mental, moral, or physical, the most common being those that arise from the intemperate use of intoxicants, through habitual carelessness or recklessness—such as may reasonably come to the knowledge of the employer—likewise charge him with liability. A single act of negligence or incompetence of an employe is not enough to fix the employer's liability for continuing to employ the employe guilty of the same.

It is, therefore, quite apparent from the above statements that the employer must be reasonably and properly careful and diligent to see that each employe hired by him has such qualifications as will enable him to perform his duties without greater risk to himself and his coemployes than the business necessarily involves.

Rules and Warnings.—Another branch of the employer's duty is that of providing appropriate rules, and the carrying out of a suitable system for the conduct of his work. No assumption is made, however, that rules can be so arranged as to guard against every contingency.

Enforcement of rules is no less a duty than the promulgation thereof. Repeated and notorious violations will charge the employer with a knowledge of the insufficiency of the provisions made and the necessity of new regulations, or of additional superintendence. In the absence of steps to secure enforcement of rules thus violated it has been held that the employer has sanctioned their abrogation, and that they are no longer binding.

Besides the general rules by which the conduct of business is determined, instructions may be necessary either in case of abnormal conditions, or of the employment of inexperienced persons. The principle lying at the foundation of this duty is the same as in the case of providing safe appliances and safe workplaces, i. e., liability does not attach on account of the dangers of the situation, but for placing the employe in a situation of which he is inexcusably ignorant. Not every contigency is to be anticipated in the giving of instructions, but such only as are probable in the conduct of the business, and while the employe keeps within the scope of his employment.

CONTRACTS RELIEVING EMPLOYER.

Employe's Waiver of Right to Recover.—Efforts on the part of the employer to make his employes insurers of their own safety by the adoption of rules, or the requirements of contracts releasing the employer from liability will, generally, be discountenanced by the courts.

Thus it has been held that a contract executed subsequent to the employe's entrance on service, relieving the employer of liability, is void for want of consideration. On the other hand it has become more or less the custom among employers to require of an employe as a condition of employment the making of a contract relieving the employer from the liability imposed by law. In England it has been held that it is not contrary to the policy of the employers' liability act to waive the benefit of the same by contract, and that such contract is binding, not only upon the employe himself but also upon his representatives in case of death. In the United States it has generally been held by the courts that a contract made in advance, irrespective of statute, whereby an employe agrees to release and discharge his employer from liability for any injury he may receive by reason of the negligence of his employer, or of his representatives, is contrary to public policy and is, consequently, void. This principle has been announced by a national court as follows: "As a general proposition it is unquestionably true that an employer can not relieve himself from negligence by any contract entered into for that purpose before the happening of the injury."

In direct contradiction to the foregoing statement is a decision rendered in which it was held that where an employe, by special written contract made at the time he was employed, and in consideration of said employment, agreed "to take upon himself all risks connected with, or incident to, his position, and that he would in no case hold the corporation liable for any damage he might sustain by accidents which might result from the negligence, or carelessness, or misconduct of himself or other employes or persons connected with the corporation, or in the service thereof," such a contract, so far as it did not waive any criminal neglect of the corporation or its principal officers, was a legal contract and binding upon the employe, and in effect waived all his rights under the law. In other words the court held that it was legal for an employe to contract with his employer to relieve such employer of all liability in damages for injuries sustained.

Where the feature of relief benefits exist a new factor is introduced and the rulings are quite uniform in favor of the contract. In general the terms of the contract are, that the acceptance of benefits by the injured employe should operate as a waiver of his right of action at law against the employer.

RELIEF ASSOCIATIONS.

Briefly described, a relief association is an institution organized by a corporation designed to furnish money benefits, and often free hospital treatment, to employes of such corporation when they are disabled by accident or sickness, and to provide a certain sum of money for their families in event of the employes' deaths. The relief association's affairs are exclusively under the management of the corporation which contributes to its funds. In addition a certain proportion of the wages of each employe who is a member of such association is retained by the corporation and turned over to the benefit fund of the association. It has become the custom to include in the application for membership in the association the following or similar agreement on the part of the employe: "The said applicant agrees that, in consideration of the contributions of the said corporation to the

relief and hospital department, and of the guaranty by it of the payment of the benefits aforesaid, the acceptance of the benefits from the said relief and hospital department for injury or death shall operate as a release of all claims against said corporation for damages by reason of such injury or death." Many of these applications, in addition to the above agreement, contain the following: "And I, or my legal representatives, will execute such further instrument as may be necessary, formally, to evidence such acquittance."

This sort of an agreement (contained as it usually is in the printed application for membership which must be signed by each employe who desires to join such association, is evidently designed to relieve the corporation of its legal liability for damages for injuries which the employe might sustain, and at first thought seems plainly antagonistic to the principles of the Common Law and the provisions of the various statutes which prohibit contracts, and so forth, waiving the employers' liability.

Such agreements, coupled with the fact of the actual acceptance of aid from the benefit fund after receipt of injury, have frequently been set up as matter of defense in suits brought against corporations for damages for injuries. The results of the decisions of the courts of different states seems to be to hold such contracts valid. It has been generally held that while a contract by which an employer attempts to relieve himself from a future liability for injuries or death of an employe would be void as against public policy, and frequently as being in violation of statute, yet the agreements or contracts now being considered are not of that class, but are only contracts for a choice between sources of compensation for the injury, where but a single source of compensation existed prior to the making of such a contract; that such an agreement recognizes that enforceable liability may arise, and only stipulates that, if the employe shall prosecute a suit to final judgment against the corporation, he shall thereby forfeit his right of action to recover from the relief fund, and conversely. It is the final choice, the acceptance of one against the other, that gives validity to the transaction.

It will be observed that it is the acceptance of benefits from this relief fund which, by agreement, releases the corporation from a claim for damages. If the employe injured does not accept such benefits, but chooses to sue for damages, his right of action is unimpaired, and in no respect waived. It is not a question of whether a corporation, by contract with its employes, can exempt itself from suits for personal injuries sustained by its employes which were caused by its negligence; that, as a general rule, can not be done. The employe does not waive his right of action against the employer, in case the former is injured through the latter's negligence, by the execution of the contract. It is not the execution of the contract that estops the injured employe, but his acceptance of monies from the relief department on account of his injury after his cause of action against the employer, on account thereof, arises.

DEFENSE OF EMPLOYERS.

Employers can not be held as the insurers of their employes; they are liable, however, for the consequences, not of danger, but of negligence on their part in the event of a breach of duty to an employe resulting in injury to him.

Assumption of Risks.—As stated in a previous paragraph when a contract of employment is entered upon the law imports into the agreement an assumption by the employe of the ordinary risks incident to the employment, and of such other risks as may be known to and appreciated by him. This is said to be a term of the contract, expressed or implied, from the circumstances of the employment, and is commonly stated as the 'trade risk.' In this connection it might be advisable to outline the two classes of risks recognized by the judiciary and known as 'ordinary' and 'extraordinary' risks.

Ordinary Risks.—Ordinary risks have been defined as those that pertain to the employment after the employer has discharged his duty as to safe work-places, tools, appliances, and so forth, and which ordinary care on his part can well guard against.

Extraordinary Risks.—Risks which may be obviated by the exercise of reasonable care on the part of the employer are classed as extraordinary, and these the employe is held not to have assumed without a knowledge and comprehension of the dangers arising from the employer's negligence. If the dangers are patent, or are brought to the knowledge of an employe, his entering upon or remaining in service is presumed to have waived his claim against the employer for resulting damages. In the first place he will be held to have made his contract in the light of existing conditions; and, as to risks arising during employment, it has been said that if an employe continues to use a work-place, tools, appliances, and so forth, which he knows to be dangerous, he does so at his own risk, and not at that of his employer. It must appear, however, that the risk was actually appreciated. While a failure to notify the employer of discovered or known risks is construed as indicating the employe's willingness to continue to work while they exist, the risk is not thrown upon the employer by a mere notification not replied to by his promise to repair. If the alternative of continuing to work with the defective appliances, or of leaving the employment is offered, and the employe continues to work, he will be held to have assumed the risk. A promise to repair, however, can be relied upon only for a reasonable time, after which the risk will be upon the employe.

Where a specific direction from the employer, or other competent person acting as the employer's representative, ordering a temporary departure from the contractual lines of duty, the risks incident to the new employment are, in a sense, extraordinary, as the new order carries the employe beyond the contract of hiring and so, also, away from his implied undertaking as to assumed risks.

Contributory Negligence.—It is a general rule that when an employe suffers an injury through the negligence of his employer he is not entitled to recover damages for such injury if his own negligence contributed thereto. Under this rule where employes and employer have equal knowledge of the danger of the service and the means of avoiding it, and the employe, while engaged in the performance of his duties, is injured by reason of his own inattention or negligence, the employer is not liable; and, where the employe is told to do a particular thing and is not directed as to the time and manner in which the work is to be done—it being left to his discretion—he is guilty of contributory negligence if he does not use the safest means of accomplishing the work and is injured while so engaged, and cannot recover damages from the employer. But an employe's right to recover damages for an injury is not affected by his having contributed thereto unless he was at fault in so contributing. Likewise an employe is not guilty of contributory negligence if, when injured, he was exercising ordinary care to avoid injury, and discharging his duties in a careful and prudent manner, and the injury was sustained by reason of negligent failure on the part of the employer to exercise ordinary care for the employe's safety.

When a risk involves such a degree of danger that a prudent man would not assume it, the defense to an action by an inured employe is not that the plaintiff by his contract assumed the risk, but that he was, by his conduct, guilty of contributory negligence. It will be observed that the line is not closely drawn

between the two defenses, nor is it always easy to do, inasmuch as the facts in a given case might support either defense. Cooley (Torts, page 674) announces the rule as follows: "If the plaintiff, or party injured, by the exercise of ordinary care under the circumstances, might have avoided the consequence of the defendant's negligence, but did not, the case is one of mutual fault, and the law will neither cast all the consequences upon the defendant, nor will it attempt any apportionment thereof."

Contributory negligence is purely a matter of defense in action b employes' for damages resulting from injuries sustained during the course of their employment, and the burden of proving it is upon the employer who seeks thereby to avoid liability for such damages.

Comparative Negligence.—The attempt to impose a doctrine of comparative negligence has been declared unconstitutional. Primarily this doctrine favored an apportionment of the fault where, in the case of inury to an employe, if the preponderance of negligence seemed to be chargeable to the employe, to award damages in a corresponding amount. Conversely, where the negligence of the employer is great, and that of the employe but slight, the latter may recover The construction placed upon this doctrine of comparative negligence is merely a peculiar restatement of the common law doctrine of contributory negligence.

GENERAL.

The past few years have been marked by a rapid increase of interest in the question of the adjustment and distribution of the burden of the results of industrial accidents, the doctrine of compensation as distinguished from that of liability coming for the first time in the United States to any widespread support. Where the idea of the employers' liability controls, the employe is given a right of action against the employer in cases where injury from accident results as a consequence of the negligence of the employer, or of some one charged with the performance of his nondelegable duties; with this, however, the rule must be considered that where the injured employe contributed by his own negligence to cause the accident, such contributory negligence bars recovery. Ordinary risks, not due to the employer's negligence, but incidental to the employment, are held to be assumed by the employe and for injuries resulting therefrom no recovery of damages can be had. It is obvious that the only right allowed the injured employe under this doctrine is the right to sue which experience has shown to involve uncertainty, delay, expense, and the ultimate acquisition by the workman of only a fraction of the money actually expended by the employer in the way of defense and of payments on judgments.

The impossibility of securing to the workman the needed protection by a mere grant of right of action for injuries for which the employer can rightly be charged is evident from a consideration of the principles of law set forth above. The employer who is the agent of the public in the matter of production, should be charged with the duty of so administering industrial undertakings that the burden of the socalled "trade risk" shall fall on the industry at large, and not be concentrated on the weakest point—on the individual workman, disabled for service through the mere fact of his employment at the time and place of the occurrence of the inevitable accident, or on the widow and children of such workman, if the accident results fatally.

CONCLUSION.

Owing to the multiplicity of the statutes passed by the legislatures of the different states, together with the fact that they are all applied and interpreted by courts composed of many different individuals whose intellectual faculties do not all work in the same grove, and whose judgment, therefore, do not always coincide, and, also, to the further fact that in no two cases are the facts precisely the same, there is always an uncertainty as to the outcome in each particular action brought for the recovery of damages for injuries. For the above reason it is no doubt true that many cases are compromised or dropped altogether by employes rather than to incur the expense of a suit at law, and to risk the uncertain outcome thereof; and, on the other hand, many employers are put to much trouble and expense in deciding suits which never should have been brought, the employes having, as the results demonstrated, no legal case.

That this condition of affairs—this uncertainty as to whether the law affords a remedy—can ever be improved while the human intellect continues to be fallible, and the present line of legislation continues to be followed, is greatly to be doubted, and it is this fault of the law in its application which led to the radical changes in the plan of legislation which have been made by Great Britain, France, Germany, Belgium, Russia, and many other foreign countries, in their compulsory insurance acts and compensation acts against accidents to workmen.

Briefly, the idea of compensation is that of an award of a fixed sum for injuries for which the employment is responsible without the necessity of litigation, or the endeavor to determine the question of fault. It is frequently provided, however, that where an employer is apparently grossly negligent, damages will be recoverable, and if the employe is willfully or grossly negligent, he shall take nothing either by way of compensation or otherwise.

Legislation upon the lines of making the employer responsible for all injuries of his employes, regardless of the question of the employers' negligence, and the system of compulsory insurance of the employes against accidents, as adopted in foreign countries, is being given a trial in several states of the Union, but as yet the subject has not really become a national issue.

NOTATION:—(1) Cyclopaedia of Law and Procedure.

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When properly used, the term onyx applies to a banded variety of chalcedony closely allied to agate. It is a purely siliceous rock, and constitutes the "precious onyx" of the ancients. The name is derived from the Greek for nail, in allusion to the wavy bands which traverse the stone, and to its translucency, both of which characteristics it has in common with the nails of the hand. Under the term travertine are included two distintc types of rock which agree in consisting of calcium carbonate, or calcite, but which have quite distinct modes of origin, one being deposited by the waters of hot springs, mainly through the agency of conferva-like plants, and the other being deposited from cold waters in caves as a result of purely chemical action. These deposits are both known as travertine, which is found wherever water highly charged with calcium carbonate runs over the surface. Much of it is loose, porous, or cellular in structure, and to this phase of deposit, as found about the orifices of springs, the term "tufa" or "calcareous sinter" is applied. When compact in texture the rock is capable of taking a fine polish, and as a general term for both spring and cave deposits the term "Travertine marble" is an appropriate designation. It is unfortunate that the term "onyx" has been applied to these rocks, which are essentially marbles.

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The necessity of having the drill bit concentric is obvious. In hand sharpening and even with some power sharpeners it is not uncommon to find one of the ends of the cutting edges protruding 1-32 to 1-16 inch beyond the others. Some manufacturers have effectually overcome this difficulty by entirely enclosing the bit under a heavy pressure while it is being forged. When this is done there can be no question of the corners falling within a circle.

From Copper To "Gold Mines"

This space is reserved for the picture of A. F. Holden, the other eminent engineer who lent his name and gave his endorsement to the electrifying report on Alaska properties submitted herewith and which will be reproduced from month to month.

NOTED ENGINEERS JOIN BROKERAGE HOUSE IN A REMARKABLY PECULIAR PRESENTATION OF AN ALASKA GOLD MIRAGE.

Extract From Report of Messrs. Jackling and Holden.

We have considered the PROBABLE capital requirements for a capacity of 6,000 tons per day, which contemplates a hydro-electric power plant; mine development and equipment, including all the necessary living quarters, both at the Perseverance mine proper and at the mill, and driving the long adit tunnel. We BELIEVE that $4,500,000 will do this work.

Our BELIEF is that the substantially INDICATED ore body is about 4,500 feet long by 70 feet wide. The value of the 600,000 tons of ore THAT HAVE BEEN MINED FROM THIS BODY IN THREE DIFFERENT LARGE STOPES INDICATES that a recovery of at least $1.50 per ton can be made. We BELIEVE that there will be 75 cents per ton profit in this grade of ore. The Sheep Creek Tunnel, which will be driven on the vein as the main haulage level, will develop this ore body at an average depth of about 2,200 feet on the dip of the vein, or about 700 feet deeper than present developments.

The character of this vein is similar in A VERY GENERAL WAY to other large deposits of gold ore in the same vicinity in which the values at a vertical depth of 1,600 feet, or 2,000 feet on the dip of the vein from its apex, are practically the same today as they were on the surface, and have been throughout the development of THE DEPOSITS IN QUESTION. We visited these mines and saw THEIR deep levels, and, if there is any inference to be drawn from the continuity of THESE ore bodies, WHICH ARE NOT, HOWEVER, ON THE SAME VEIN AS THE PERSEVERANCE, one MIGHT BE TEMPTED to say that there is a PROBABILITY of ore 2,500 feet deeper than the so-called Sheep Creek Tunnel which we contemplate driving, BUT, while the PROBABILITY is there of the vein and values extending to great depth, THERE IS NOTHING TODAY TO WARRANT ANYBODY IN STATING THAT IT IS A FACT THAT SUCH WILL BE THE CASE.

There are substantially 50,000,000 tons in the ore body we consider definitely INDICATED. There is a PROBABILITY of another 2,000 feet to the east of the 4,500-foot ore zone previously mentioned, which, from surface indications, would seem FAIRLY CERTAIN to contain ore. Beyond this is some 1,800 feet of the vein concerning which we have NO FINAL OPINION one way or the other, AS WE VISITED NO WORKINGS OR OUTCROPS from which we could secure sufficient data to form accurate deductions. While we cannot at this time state that there IS ore here, there were several SMALL MINES worked almost at the extreme east end of the vein on this property, which INDICATES that this 1,800 feet will undoubtedly produce considerable ore and PERHAPS LARGE QUANTITIES. If we do not consider this in the PROBABILITIES, it is certainly well within the POSSIBILITIES.

This letter is based solely on a consideration of $1.50 recoverable value as ore. If one should figure on lower values, assuming 75 cents as the total cost of mining and milling, the tonnage now indicated in INDEFINITE, but certainly enormous. We BELIEVE that sound mining business will INDICATE that for the installation now proposed and for an operating period of, say, two years, IT WILL BE WISE TO CONFINE OUR WORK TO THE HIGHER GRADE ORE. There can be, in our opinion, little doubt that at some time in the comparatively near future A VERY MUCH LARGER PLANT than the one now proposed will be installed for the purpose of working a larger tonnage of the normal grade ore we now EXPECT will be developed, or of utilizing the apparently vast quantity of lower grade material.

The INDICATED earnings from the installation now contemplated are approximately $1,500,000 per annum. Considering the TREMENDOUS POSSIBILITIES, and we use the word "tremendous" advisedly, we BELIEVE this mine to be a LEGITIMATE purchase at $15,000,000 and A BARGAIN at $12,000,000, provided that, in both cases, a development, equipment and working fund of $4,500,000 is made available. You must understand and appreciate that we do not consider the 6,000-ton per day development and installation as the ultimate possibility of the mine or anywhere near it. The POSSIBLE tonnages of ore INDICATED in this property APPEAR to be greater than any vein deposit WE know about.

We EXPECT the first unit of the new mill to be in operation on or before January 1st, 1915. We really BELIEVE that, barring accidents, the time MAY be made July 1st, 1914.

(Signed, D. C. JACKLING,
July, 1912. A. F. HOLDEN.

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In driving the Laramie tunnel in Colorado, the average depth of hole was 17½ feet; a stick of 60 per cent powder was placed in the bottom of the hole; then the primer, on top of which five sticks of powder were used except in the case of cut holes, each of which were loaded with three or four extra sticks. The three lifters were loaded to the collars in order that the broken ground should be thrown as far as possible from the face.

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One of the papers the other day said that the allotment of "$5 paid" stock in the Alaska Gold Mines Company had been made by Hayden, Stone & Co. Wonder how much of it the "bankers and brokers" of Salt Lake got?

GEOLOGY AND MINES OF HIGH GRADE DISTRICT

By WILLIAM H. STORMS.*

High Grade mining district, which has the past few months attracted considerable attention from prospectors, and investors as well, is situated in Modoc county, California, and extends a short distance northward across the state line into Oregon. It is on the summit of the Warner range of mountains which lies between Goose lake, on the west, and Surprise valley on the east. The entire district is in a region of volcanic rock—andesite and rhyolitic flows and tuffs, forming the central portion of the range with later flows of basalt and agglomerate on the eastern borders.

The history of the district extends back for many years, but the entries are few. At one time the government maintained a military post in Surprise valley, known as Camp Bidwell. This place, now called Fort Bidwell, is about twelve miles southeast from High Grade, and is near the eastern base of the Warner mountains. Soldiers from the fort, and others, found gold in the Warner range many years ago, but the principal prospector was a man named Hoag. He did considerable work at the surface on various claims, and the district came to be known by his name. In 1905 new discoveries in these mountains resulted in renewed interest in the possibilities of the region, and then, for the first time, some real development was accomplished, which has since been followed by a much more general interest in these prospects and the renaming of the district, it being now known as High Grade. It is needless to say that this newest name for an old district was suggested by commercial considerations. Nevertheless, there is high-grade ore in several mines of the district.

The geology of the district is comparatively simple when viewed in its broader features, but somewhat complicated here and there locally. The Warner mountains consist of a thick series of volcanic flows and sediments which form a portion of the great volcanic plateau which covers all of Modoc county, a large part of Shasta and Lassen counties, and extends northerly and easterly into Oregon and Nevada. The general history of the Warner range, as indicated by exposures in that region, shows that a vast mass of nearly horizontal volcanic strata, chiefly andesites, rhyolites, and tuffs, were cut by a great fault which skirts along the east shore of Goose lake. In fact, it looks as thought Goose lake were the direct result of the faulting of this region. Israel C. Russell has written a most interesting description of a number of these faults which occur in southeast Oregon and extend southward into California. Several of the valleys formed by the faulting of the great volcanic plateau are the sites of lakes; others have been filled with detritus and are now fertile valleys. Along the east side of the Goose lake fault the volcanic beds were lifted 2000 feet or more, the entire series dipping 10 to 20° to the eastward. Russell describes a similar fault along the eastern base of the Warner range in Paradise valley, so the Warner mountains as a whole represents a great fault block, lifted above the surrounding valleys, the strata having a general dip to the eastward. In the central portion of this range the rocks do not all lie so nearly flat, but are found more or less disturbed, at some places standing in vertical position. There are in the central area several minor faults which have divided the district into a number of fault blocks. It is in the vicinity of these faults that the principal mineralization has taken place, along zones of brecciation, or following fissures in the breccia, which strike in various directions, though usually north-south and east-west. Where these fissures have intersected each other there has, in some places, been an enrichment, and it is the occurrence of this rich ore that doubtless suggested to the miners the name of the district—High Grade.

There is evidence to prove that after the uplift of the range and the formation of the brecciated zones and fissures in which the gold-bearing ores are now found, there was a long period of erosion, found planed off in some localities on the as the strata of rhyolites and tuffs are higher hills, and the gentle slopes to the northeastward, which at first might easily be mistaken for dip-slopes are really the result of erosion. The theory of a period of erosion at that time is proved by the fact that the later flows of basalt and andesite with their accompanying tuffs, overlie the adjacent hills to the eastward, tongues and remnants of the basalt being found lying on the older rhyolite and tuff, which would be impossible had the upper rhyolite not been removed by erosion. These later volcanic rocks have no connection whatever with the mineralization of the district, but it is interesting to know that the ore-bearng formations extend eastward and northward beneath the more recent volcanics, as it admits the possibility of the extension of the known mineralized zone in that direction. I was shown some ore, a silicified brecciated rhyolite, from the east side of the Fort Bidwell range, that much resembled some of that found in the High Grade district. For lack of time I did not visit that locality. Since the period of basalt flows the entire region has been subjected to tremendous erosion, as indicated by canyons 3000 feet deeper than the top of the basaltic plateau.

The accompanying sketch, Fig 1, is a northeast-southwest cross-section of High Grade district, drawn through Yellow mountain, one of the highest points in the district. It will give a general idea

Fig. 1. Cross Section at High Grade.

of the structural geology of the district as a whole. The time at my disposal was not sufficient to admit of a critical examination of the entire region in detail, so at this time generalizations only can be submitted. The sketch map, Fig. 2, shows the drainage of the country, and on it are also indicated some of the faults which appear to have important bearing on the structural features of the district, and incidentally on the mineralization.

Fig. 2. Sketch Map of the High Grade District.

I did not ascertain the natural succession of all of the rocks in the undisturbed area lying in the western part of the Warner range, but know that these rocks are principally white flow-rhyolite and white rhyolite-tuff. These comprise the greater part of the front or west range. About half way between the base of the mountain, and High Grade camp, I believe the rocks have been faulted,

* State Mineralogist of California.

and some of the rhyolite and tuff found in the front range appears to be repeated to the eastward of this fault, if it actually exists. This should be verified, as the fault-line may be said to be suggested by topography rather than by actual evidence. However, about half a mile east of the electric light plant on Pine creek, an abrupt facade of purplish rhyolite rises several hundred feet above the bottom of the canyon, with a steep talus at its base. Its course is a little west of north and east of south. Bluffs and knobs of what appeared to be the same rock may be seen for a distance of a mile and a half or more, occupying a similar position on adjacent hills, and in direct line with the main palisade on the north side of Pine creek. This I think to be, in all probability, the main cause of bringing the rhyolites of the front range once more to the surface in the vicinity of High Grade. If this fault actually occurred it must have a throw exceeding 2500 feet.

The principal rocks of the High Grade district are a white flow-rhyolite at the top, underlain by a bed of variable thickness of white rhyolite-tuff, usually buff colored near the surface, and this in turn is underlain by purple porphyrite rhyolite. These rocks extend from the extreme northerly end of the district, where they pass under the more recent basalt, to the south end, at the Sugar Pine and Mountain View mines of the Fort Bidwell Consolidated group. Southerly from there the rock is principally an ancient andesite of very fine texture, ranging from bluish-black to greenish-black and grayish-black in color. I did not see a single intrusive dike in this portion of the range, though dikes of basalt cutting the tuffs and rhyolites south of Cottonwood creek are numerous These latter are five to six miles southwest of this district. In that vicinity, on and near the Snyder ranch, are also fissure veins containing gold, some of them being very encouraging prospects.

There are several types of ore deposit in High Grade district. The most common are zones of brecciation, highly silicified and auriferous. These occur in flow-rhyolite and tuff, and also in the earlier andesite at the south end of the district. A second type is that of rather small fissure veins cutting at high angles through the zones of brecciation. In some of the mines these fissures run at nearly right angles. At the intersections rich ore has been found.

A third type occurs in the form of nearly flat sheets of rhyolite or tuff, highly silicified but with little or no brecciation, though auriferous. These may be considered as zones of impregnation. Still another type is the fissure vein occurring outside of any zone of extensive brecciation. This latter is represented in the North Star mine, where a fissure, varying in size from an inch or two to three feet or more, runs through the earlier andesite. Some of this rock contains payable ore; some of it is low grade. The quartz is white and sacchaoidal, and shows some blue and green copper carbonate. This is said to be the discovery vein of the district. It is developed by several hundred feet of workings. It is at present held under lease and option.

The Sunset workings, consisting of about 800 feet of development, are entirely in the earlier andesite, which here is found sheeted by pressure, the structure making it appear like a nearly vertical dike, or intrusion. I think that a fault of considerable displacement passes just east and south of this locality, its course being denoted by the neighboring canyons, Evening Star gulch and Sunset gulch. On the opposite side of this canyon and about 100 feet south of the Sunshine mine, the basaltic strata of Mount Vida are seen to have a northwesterly dip, which is opposite to the general dip of the formation to the northward. This fact appears to lend color to the probable existence of the fault here referred to. This fault has a curving strike the concave side facing the west. Unfortunately, at the several points where these faults pass through low saddles, in every instance examined, the evidence of their existence is obscured by low flat surfaces, covered by deep soil, or piles of rock.

The Fort Bidwell Consolidated property comprises several claims. The Mountain View, one of these, occurs in a zone of breccia at the contact of the earlier andesite with the rhyolites, whereas the Sugar Pine, another of its properties, is wholly is the rhyolite.

The Shasta View, adjoining the Mountain View on the southwest, is wholly in the earlier andesite. Both of these properties have some high-grade ore, and much that is too low in value to ship, but which is still a good grade of milling ore.

The Fort Bidwell company is operating a 10-stamp mill. The ore is delivered to the mill from the Mountain Vew by drift and tramway on the mill-level, and from the Sugar Pine, which is on the opposite side of the divide, by aerial rope-way. The workings of these two claims are to be connected, when all ore can be sent to mill through the main adit, which will prove a great advantage, as the deep snow in winter interferes with the operation of the rope way.

The Alturas company's property is on the east slope of Yellow mountain, and is wholly in the rhyolite. The principal shaft is 105 ft. deep. Hoisting is done with a horse-whim. In this shaft a shoot of ore in purple flow-rhyolite is being developed. This ore contains more sulphide (pyrite) than was observed in any other mine in the district. Yellow mountan slopes from its crest, at 10 to 15 deg. eastward for a distance of a mile, when it plunges steeply downward into Evening Star gulch. Along the rim of this sudden descent, and on the flat back of it, are a number of promising prospects. Some of these belong to the Alturas company, others to the Seven Lakes company, while still others are held by the locators. Among these latter is the Dandy Fraction, which makes an encouraging surface showing. These workings are mostly in the brecciated flow-rhyolite, though a few are in the tuff. Some of them are of the impregnation type. On the northeast side of this rim considerable work has been done on a claim called the Mountain Sheep, but the mine is idle, due to pending litigation. The cause of the contention lies in the fact that the Mountain Sheep conflicts with three other locations, having been laid diagonally across them.

To the eastward of Yellow mountain and between it and Camp High Grade is the property of the Big Four company. The ore deposits here are of several types, including practically all of those found in the district. One of these is that of a flat sheet of much silicified rhyolite which shows little evidence of brecciation. This ore is being treated in the company's 5-stamp mill, with good results, so I was informed. In this property considerable work has also been done on a nearly vertical fissure vein, in which high-grade ore was found.

The Sunshine, Yellow Jacket, and Last Dollar mines are on Sunshine hill and are practically in the camp of High Grade. The ore here occurs mostly in brecciated masses of rhyolite with north-south and east-west fissures cutting the zones of brecciation. It is at the intersection of these fissures that the rich ore has been found. The first shipment of 10 tons carried over $250 per ton gross value. Another shipment was ready at the time of my visit. On the Sunshine hill there are at least three separate zones of brecciation, and there may be others not as yet developed. The Sunshine claim has been divided into a number of blocks, nearly all of which had been leased, and the lessees were eagerly working to develop their several holdings. To the eastward on a neighboring hill the Gold Shore claim resembles the Sunshine, having the same rhyolite breccia and silicification, which is an

accompaniment of the auriferous ores of profitable grade everywhere in this district.

On the plateau north of High Grade is a group of claims owned by the Modoc Mines Co. A shaft had been sunk to a depth of 60 ft. at the time of my visit and some excellent ore found. The ore here is in the brecciated rhyolite. This company has built a substantial headframe and has a well equipped steam-hoist.

There are numerous other claims scattered throughout the district, but which had so little development that no particular mention is made of them, though some of these show good prospects in gold. I observed fissures in various parts of the district, in which the rock was much kaolinized and stained by iron oxide, but all of the occurrences of this character that came to my attention were low in gold. There may be exceptions to this, but I did not see them, if there are any.

There are some striking features in the topography of this district, which are due principally to two causes, first, minor faulting, and second, climatic conditions. Naturally the first cause has left the more noticeable results as observed in the steep slopes on one side of the hills which are probably fault scarps modified by erosion. There is undoubted evidence of the former presence of small glaciers, as indicated by the kames, moraines, small lakes, and swamp holes, in the canyons of the region. Cave lake, Lilly lake, Opal lake and others are all of this origin. Since the glacial period erosion has progressed so far as to destroy practically all evidence of its former existence except the features above described.

Another pronounced feature in the topography is in the so-called "rock piles." These are generally the locus of ore disposition. All the ore of the camp so far as I observed, is extremely silicious. The already dense rhyolites, in the zones of fracture and brecciation, have been rendered additionally hard by the infiltration of silica, and these zones being more resistant to erosion have a tendency to stand up in wall-like masses above the surface. These walls have been attacked by alternations of freezing and thawing, and the result is, as seen, a breaking down of these hard outcrops and the scattering of the fragments, large and small, over a considerable area in the immediate vicinity of each occurrence. This has made the development of the ore-bodies rather backward, as so much superficial work was required and is still being done to find the gold-bearing rock in place. The prospector first finds "float" ore in the pile of loose boulders. He then decides, as well as he can, upon the most likely point to find the orebody in place. The loose rock is often from 10 to 30 ft. in thickness and it requires considerable preliminary work to reach solid rock. In most places an adit run from some place on the mountain side would best solve the problem, but these lessees want to find their ore and stay with it, which from their point of view, is good policy. Owing to these peculiarities, the hardness of the rock, shortness of the summer season, and lack of present liberal financial aid, it will probably be another year before much more is known of the geological conditions obtaining in this district, than is indicated in this description, for the work of development will proceed slowly at first.

The metallurgical problem is not a difficult one. At present, simple amalgamation is the only treatment given these ores, but the percentage of value thus saved is sometimes discouraging. The gold is extremely fine in most of the ore, though the richest ores occasionally contain much visible gold. I believe that the cyanide process will satisfactorily solve the metallurgical difficulties. The only sulphide observed was pyrite, with a single exception, which was an occurrence of mispickel. Copper also occurs in a few places, but in small amount. Generally speaking, so far as developed, iron sulphide is far from abundant in these mines, the gold appearing to be associated rather with the secondary silica than with sulphides of the base metals. Most of the gold is accompanied by silver, some of the bullion running as low as $12 per ounce. Most of the ore affords excellent examples of that condition so interestingly described by Franz Posepsy as "crustification."

The district is an ideal summer camp. It has the advantage of abundant timber and water, and is but nine miles from the railroad, at New Pine Creek. Deep Creek, which heads just north of High Grade will furnish abundant power which can be transmitted into the district. So, on the whole, High Grade may be said to possess the elements of success. The energetic men who are at present interested in the district, and who, by the way, are mostly from Colorado, where they do not look upon the deep snow of winter as an insurmountable obstacle, will, without doubt, make the most of the situation at High Grade and achieve the success to which they are entitled. At present there are no saloons in High Grade, and little or no gambling, nor is there either church or school, but the people of the camp are optimistic to a degree, and most of them have calloused hands, which speaks much for their faith. A portion of the district—that at the north end, is on "school land," section 36, which was purchased from the state. The rest of it is in the forest reserve.

It has bees repeatedly stated by some of those interested, that High Grade district is "another Cripple Creek," and that "it will eclipse Goldfield." These and similar comparisons with noted mining districts have been made. Geologically it bears no resemblance to either Cripple Creek or Goldfield. The mineral deposits are only in a remote way similar to those of Goldfield, and very unlike those of Cripple Creek. Each mining district must stand or fall upon its own intrinsic merit. High Grade will, without doubt, produce some profitable mines, but how many remains to be determined by development and ore treatment. Already the newspapers are beginning to contain statements attributed to me, which I never uttered. The above description of the camp is a truthful one, and presents the district to the mining world as I saw it during my visit of a few days. The work was a reconnaissance at best, and the statements made are subject to change as development proceeds and the district becomes better known.

That every claim, or group of claims, in High Grade district will become profitable, I do not believe, but the superficial showing certainly justifies energetic prospecting and that, too, in some places where little has as yet been done. There is a probability that the development of the surrounding country will extend southward to Mount Vida and beyond, and some encouragemest has already been given prospectors in that direction. I did not visit that locality, however, and know of it only from the description of those interested there, who showed me some ore which they said came from that locality.

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Pumps often give trouble because of an unequal pressure within the steam-chest acting on the area of the steam valve or the valve stem. As the valve stem extends through only one side of the steam chest there is a constant tendency to blow it out. To overcome this trouble the use of a coil spring between the bracket and collar has been recommended. This spring should be given sufficient tension to counter balance the action of the steam acting on the area of the valve stem. While the action of the steam is to force the valve stem out of the chest, the spring forces it in again and therefore the forces are neutralized and the valve stem stays where it is left by the tappet arm.

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The tungstate of manganese is known as huebnerite.

Mines and Methods

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Mines and Methods

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CONTENTS:

A feature of the strike at Bingham that has caused not a little mental calculation on the part of those who read the daily statements put out by the Utah Copper management is the vast amount of ore that is being handled by a comparatively few men. The other day, when the company's report to the papers claimed that about 300 men were at work, it was declared that about 12,000 tons of ore had been mined and shipped to the company's mills. When this item was written the company was claiming that it had about 1000 men at work and that 10,000 tons of ore was being daily delivered at the mills. When the strike started, on the 18th of last month, it was said that over 3500 men went out at the Utah Copper mine alone. What those who are figuring are trying to get at is this: If 300 to 1000 men can now produce ore at the rate of 10,000 tons a day, or one-half the capacity rated before the strike, why was it necessary to employ 3500 to mine 20,000 tons? One of two things seems certain—either the company is not doing what it claims it is now doing, or else things were being run in a mighty slip-shod and extravagant fashion before the strike.

ALASKA GOLD MINES FIZZLE

Well, we certainly baited right last month, for it was no time, hardly, after the September issue of Mines and Methods made its appearance in the East until we got a "raise" from the "sharks" who are (or were) claiming such great things in the exploitation of the Alaska Gold Mines Company—that proposition so tactfully (?) described by those EMINENT engineers, Messrs. D. C. Jackling and A. F. Holden, in their "report," which we reproduce again this month. Don't, for the love of Mike, accuse us of a purpose of "rubbing it in" by continually reproducing this truly remarkable document, because that would not be fair to the eminent authors of it. That "report," apparently, was compiled as a response to the encore demanded by those who for years have been profiting by the exploitation of the claimed engineering prowess of the first signer and the known and acknowledged ability of the other, and the only thing about it that baffles our comprehension is how the second signer of the "report" was mesmerized into attaching his signature. But, seeing that it is there, join with us in what ought to be counted as a laudable desire to finally witness the placing of life-sized busts of these masterful engineering craftsman in the world's hall of fame.

In the last issue of this journal we did what we could to help out the proposition offered by the sponsors of the Alaska Gold Mines Company by going somewhat into detail concerning features of the company's undertaking that were evidently overlooked in the "report" referred to. And while the exploiters probably had in contemplation a different method of convincing the world that Manager Jackling could easily wrest a profit of 75c. a ton from $1.50 ore BELIEVED to be scattered through a precipitous, glacial, mountainous mass of badly shattered slate and greenstone in which engineers for the Geological Survey have declared it would be impossible to mine the ore without also mining the waste material, we tried to make it plain how advantageous it would be to them if our readers would take on some of that "$5 paid" stock at $9.50 to $10. They won't call on you for the other $5 until next June and maybe by that time they will be ready to give you a crack at another issue of installment stuff that will look like gold nuggets, freshly plucked for the occasion

Excuse this rather facetious diversion. What we started out to call your attention to is the following half-hearted acknowledgement that the scheme has proven much of a fizzle so far. Of course this admission is screened as much as possible by silly boasts in one place, boosts for the promoters in another and apologies elsewhere, with here and there a reference to what mythical "mining people in Alaska" and others BELIEVE can be done. We are reproducing the whole article, just as it appeared in the publicity journals in the east whose utterances are controlled by the promoters of the game, and copied by the claquers here. Read it carefully and then, if you are able to exercise calm judgment, we are satisfied you will be willing to let the promoters continue to hold the stock:

> The 100 per cent premium put on Alaska Gold Mines so soon after the subscription and allotment by Hayden, Stone & Co. is causing profound interest throughout the mining world. The market seems to be well established around $10 and is perfectly open and free and the people who are turning in the original bonds on the property are taking payment therefor in stock at $10 per share. This price is not really 100 per cent premium. It is only 50 per cent premium, because the subscription price is $10 and the first payment $5

Read the above paragraph again and let it soak in.

> The circular of Hayden, Stone & Co. is remarkable in its indefiniteness, although the apparent effort of the financial statement was to be most definite. Simply stated, the fact is that when the bonds of the present company are taken up, the company stands with 750,000 shares issued for $10 per share cash, or $7,500,000. Of this, $3,000,000 is paid for the property and $4,500,000 goes into the treasury for equipment and development of the property.

Some admission in the first two lines of the foregoing paragraph. See the "report."

> This is the real secret of the enterprise. The weakness of most mining promotions is that more is paid for the claims of the alleged mine than is raised to really make the mine. In this case Hayden, Stone & Co. insisted that the purchase price should be rock bottom with no profits or commissions to the promoters except that the bankers should receive banker's commission on the subscriptions. The promoters in the enterprise have got to look for their profits on the same basis as the subscribers, the only difference being that they had priority in allotment of stock at the same cost as other subscribers, $10 per share, one-half down.

So, when the promoters sell "$5 paid" stock to you for $9.50 or $10, they are doing fairly well, are they not?

Another remarkable thing about the promotion is the modesty of the claim as to the richness of the ore. While the Alaska Treadwell, across the Gastineau channel, with the largest gold mining equipment in the world, is reporting an expense of $1.52 per ton as its total cost of mining, milling, treatment and all overhead charges, the Alaska Gold Mines makes a claim of only $1.50 per ton recovery. The Alask. Treadwell made a recovery last year of $2.35 per ton from ore assaying $3.07

That shows the fraud of this new promotion clearly, does it not?

The Alaska Treadwell, however, is raising ore from under an arm of the Pacific ocean and from a vertical depth of more than 1000 feet. In fact, the mine is now opened under the ocean to a vertical depth exceeding 1400 feet.

On the other hand, the Alaska Gold Mines company is largely an overhead stoping and caving proposition in which the mining saving may be 40 to 50 cents per ton. The operations will be on a very large scale. The value of the ore has been put at a minimum, according to other Alaska people, who believe there will be much ore running $2 and above in these claims.

If, therefore, there is any deficiency in the estimated cost of treating this ore it may be somewhat made up by increased value in the ore. Mining people in Alaska in no way identified with this property believe that both estimates of the value of the ore and the cost of the treatment, are unduly low.

As the Alaska Treadwell treats 5000 tons a day under 1000 stamps, gold mining people believe that, even with the mine overhead instead of underneath, it will be very difficult to cut the Alaska Treadwell's costs of handling a ton of rock in half, or to goodly increase the efficiency that has been reached in the Alaska Treadwell after thirty years' work.

We thought something like that ourselves.

However, as the German banker once said, "Everything can be improved." The people who manage the Alaska Gold Mines have made the greatest record of low operating costs ever seen in the copper field and have demonstrated, through some years of opposition and criticism, that they were right in their predictions of low costs in handling rock on a large scale in the Utah Copper mine. In fact, backed by the Utah Copper mine record their estimates of cost are entitled to as much weight as is the record of the Alaska Treadwell.

Lets see; the Utah Copper claims to mine a ton of ore for 86c. and it saves nearly, if not quite one-half of the copper content in milling. That will be a fine record to make on $1.50 gold ore.

A few years hence the mining world will be on the qui vive to see how close the Alaska Gold Mines Company comes to an operating cost of 75 cents per ton. Considering that Alaska has geologically a very much larger gold bearing area than was ever uncovered in South Africa, the eyes of the whole world will in due time be turned to the Alaska Gold Mines Company and the Juneau gold belt.

The successful flotation and the handsome premium placed upon Alaska Gold Mines shares is bound to be much more far reaching than State street or Wall street. If the success of Utah is duplicated in Alaska Gold Mines the gold mining interests of the world will be more affected than have been the copper mining interests by the phenomenal record shown in the Utah porphyries by the same management.

It's a safe bet that Governor Spry and Colonel Jackling wish that the election was over.

"Mine and Methods Extemporizes"

From Deseret News, Oct. 2.—It was learned this morning that the recent visit of Allen H. Rogers, a New York engineer, to the Ohio Copper Company several weeks ago was for the purpose of making a number of mill tests for F. Augustus Heinze. Mr. Rogers has done this kind of work a number of times for various other companies in the West and at one time made mill tests on the Boston Con., as well as the Utah Copper.

When the Bingham Review published an account of Mr. Rogers being in camp and examining the Ohio Copper, it was stated that it was supposed that he represented Hayden, Stone & Co. The opportunity was seized upon by a periodical published locally to make a story that the Utah Copper was about to acquire the Ohio Copper. Utah Copper officials, when asked about the story, flatly denied it.

It was charged in the article that the Bingham Review was owned by the Utah Copper. This was flatly denied this morning by the three persons interested in the paper and at the Utah Copper office. —Bingham Review, Oct. 4.

As indicated in the credits given for the item quoted above, the Bingham Review culled the item from the Deseret News. The funny part or it is that the scribe who supplied the News with the story is also one of the editors of the Bingham paper. This item charges Mines and Methods with saying that because Engineer Rogers was supposed to represent Hayden, Stone & Co, the Ohio was about to be sold to the Utah Copper Company. The writer of the foregoing item, of course, knows that he is not telling the truth, as will everybody who read the article in Mines and Methods last month. What we had to say was not alone predicated on the fact that Mr. Rogers might be working for Hayden, Stone & Co., but on that statement and the following remarks from the Bingham Review, which we quoted: "On account of the close association of the Utah Copper with the firm of Hayden, Stone & Co., it is pointed out as possible that the company will take over the Ohio Copper Company." Of course, if the News and the Review had wanted to be honest in the matter they would have acknowledged that it was the Review and not Mines and Methods that drew the conclusion complained of.

But all that is unimportant. The main thing is that "Utah Copper officials, when asked about the story, flatly denied it"—therefore, to use present election campaign parlance, the Bingham Review was a "liar." But we have reasons for still believing that the Bingham Review was not wrong. Had it been, the Utah Copper officials would not have bothered their heads about it; and the reasons why we believe that Ohio Copper IS destined to become a part of Utah Copper, were plainly stated last month.

Now, in reference to the last paragraph of the item quoted at the head of this article. We did not say or charge that the Bingham Review was owned by the Utah Copper Company. What we did say was that the paper was LOOKED UPON as the company's personally owned mouthpiece. And so it is; and if the company's interests do not own it they are lucky, that's all, because its service could hardly be better if it was paid for.

In the meantime, Mines and Methods stands pat on everything it said last month concerning the possibilities of a sale of the Ohio and the Mascotte tunnel to the Utah Copper Company.

STRIKE SETTLEMENT ABOUT DUE

At this writing it looks as though the strikes at Bingham and Ely, Nevada, may be settled within a few days. During the six weeks that the contest has been on very little trouble, considering the great number of men concerned, has occurred. Some of the "fighting deputies" tried at different times to precipitate trouble, going to the extent, on one or two occasions, of shooting at strikers and beating them over the heads with guns and otherwise attempting, according to reports from onlookers, to "start something." On the other hand, yesterday morning, (the 25th), men reported to be strikers fired on a squad of workmen and "deputies" at the United States company's mines in which two or three workmen and one deputy were wounded. Inside of a few minutes hundreds of armed deputies and guards were in pursuit of the offenders and, while the entire day and night was occupied in a search for them, they were not apprehended.

We can not believe that the leaders of struggle at Bingham, on either side, are responsible for this outbreak, because day after day word from camp has been to the effect that no serious trouble was apprehended; that the strike leaders had been taking extreme precautions to prevent any of their numbers from committing acts of violence of any description. It seems, therefore, that the trouble of yesterday was more the result of too much display of force and authority on the part of ambitious "peace officers" than anything else.

As negotiations for an early settlement of the strike at Ely are under way, the belief is today that yesterday's regretable affair will not interfere with an early agreement in Utah, particularly as recognition of the Western Federation of Miners as a condition has been withdrawn.

BELLINGER IS POPULAR

That Mr. H. C. Bellinger, formerly at the head of the metallurgical engineering staff of F. A. Heinze, is highly thought of at Cobar, New South Wales, where he has been general manager of the Great

Cobar mines and smelters for the past four years or more, is shown by the following from the Cobar Western Age of September 14:

All Cobar folks will regret to know that the respected and genial general manager of the Great Cobar, Limited, is shortly to have a holiday. Also, it is safe to say that all will wish him a pleasant time while away, and that he may return much benefitted by his trip. As the head and leading spirit of such a stupendous cern as the Great Cobar Co., Mr. Bellinger is a busy man, and he is, after four years' continuous grinding at the mill, justly entitled to his four months' spell.

Few other men in his position could have steered the great undertaking safely through the troublous times of the past four years as he has done and yet retain the confidence of both his employers and employes. His cool and calm temperament, coupled with his great tact, has enabled him on more than one occasion to avoid labor troubles, while his at all times genial and kindly manner to the men has made him extremely popular with all those engaged on the mine, from the insignificant nipper to those in the highest authority. At all times courteous, ever ready to listen to any complaint, and always willing to redress a legitimate grievance if possible, he has won such an amount of esteem from those placed under him that falls to the lot of a few situated in similar positions. It is no exaggeration to say that there's not a man or boy on the Great Cobar mine but will be pleased to hear Mr. Bellinger is about to have a rest; but they will be still more pleased to know that his absence from Cobar will be only temporary.

And Mr. Bellinger's popularity is not confined to the mine employes alone. If he is only away for four months, Cobar will miss him. An excellent boss and a capable manager, he has also proved himself a real good citizen. Notwithstanding his many duties, and the great calls on his time entailed through his position as superintendent of the greatest copper producer in Australia, Mr. Bellinger never shirked his duty as a townsman. No matter what movement was mooted having for its object the advancement of the interests of the town, he was ever ready to give a helping hand; while the contents of his purse were always available for any deserving cause. A sport, a gentleman, and real "white" to the backbone, is it any wonder the people of this town should rejoice that Mr. Bellinger is to have a well-earned rest. May he return strengthened and vigorous, so that he may, when he comes back, in time realize his great ambition to make the Great Cobar, Limited, a dividend payer.

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Judging solely from the action of the copper metal market during the past six weeks there certainly has been a great accumulation of hidden copper somewhere. It was loudly proclaimed immediately following the strike at Bingham (on Sept. 18), that the curtailment of output would at once result in the rapid advance of copper metal prices and that producers would have a hard time to prevent "a runaway market," much as such a happening was to be deplored. Copper mining stocks also were to soar skyward and join in the runaway market; but they have not done so and producers are seemingly glad of the chance to get rid of some of the accumulated metal and thus prevent a break in price that was nearly due when the strike was called. What a lot of brazen frauds these modern market dopesters are, anyway!

—o—

If the figures given by the daily press during the past month are to be given credence—and it is hard to believe that the daily press here would tell the truth if it were possible to avoid it—the Utah Copper Company is now maintaining an army of "deputy sheriffs" totaling 300 or more. The sheriff has assured the public that the county does not have to pay these men and when anything happens at camp involving the sheriff's force in any way, a prompt denial is made that any "regular" deputies were concerned. By what authority the sheriff swears in "deputies" for whose acts he is not in any manner responsible is a feature of the industrial struggle at Bingham that has not yet been made clear. And what is the governor doing to allow it.

—o—

In a recently promulgated statement the Guggenheim Exploration Company places a value of $23.50 a share on its 404,504 shares of Utah Copper stock. Some difference between what they seem to consider it worth and the price at which it is quoted on the New York Stock exchange by the "laundrymen" who handle it. Wonder if the Guggenheims right now would not be willing to take $47 a share for all they own? If you think not, try 'em with a real cash offer.

—o—

General Manager D. C. Jackling, of the Alaska Gold Mines Company, is having a $300,000 yacht built on Puget Sound. It is to go into commission next spring and, according to the information supplied by a local paper, will be used mostly for business and pleasure purposes in Alaskan waters. We had an idea that Sheep Creek was unnavigable, but possibly we are mistaken. We respectfully suggest the name of "Aurum" for the new boat.

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Right on top of the advance of wages in the camp of Butte came the announcement that the Amalgamated Copper Company had increased its dividend rate from 5 to 6% per annum. Some managers are the men in control of the mines of Butte.

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HERE IS YOUR CHANCE

One of our valued subscribers in Bisbee, Arizona, (Mr. D. W. Art, P. O. Box 711) wants to sell a group of claims, either for cash, at a prospect price, or on a working bond. If you want to get in, here is your chance. This is the way he describes his property:

Anaconda Copper.—Eleven claims, located in Warren mining district, Cochise county, Arizona. The group is located on the west contact of iron-porphyry and lime on line, and about 2,000 feet west of Shattuck, and joins the Copper Queen on the trend of developed ores in the Queen and Shattuck properties. The Shattuck has developed extensive high-grade ore bodies on the 400-foot level. Three of the claims are patented, and on these are thirty-five-foot shafts showing iron-porphyry, quartzite, devonian and carboniferous lime. The formation is identical with that of the producing mines, and the real mineralized zone denotes that orebodies will be developed at no great depth. Orebodies do not show on the surface at Bisbee; it usually requires 400 to 800 feet in depth to develop orebodies in this district; the ores are usually found in deposits in the fault lines of the iron-porphyry contacts. Nature never fakes in Bisbee.

—o—

Experiments have shown that unless there is an unusually large amount of dust in suspension in the air, ignition does not take place from a naked flame. Dust explosions are the result of violent compressions simultaneously with the production of a large, flaming area by the explosion of a charge.

—o—

Steel tools may be hardened by using a solution of one gallon of common fish or whale oil and one pound each of beeswax and resin. Put into a kettle and heat till it comes to a boiling point, stirring it once in a while. When thoroughly mixed it is ready for use. Heat the steel till the scale rises a little, then immerse in the oil. When cool, heat over a clean fire till cherry red in the dark.

—o—

Leaky valves may be repaired in the following simple manner: Remove the hood and sandpaper the brass valve disc bright where it sets on the seat, then go all around with a hot soldering iron and place a coating of solder all around it; when it is put back it will be found perfectly liquid tight. This scheme is not effectual where high-pressure steam is used, as it will not stand long in this case.

—o—

Mildewing of canvas is prevented by applying the following composition: Sugar of lead, powdered, 3 pounds; water, 15 gallons; dissolve thoroughly and take of powdered alum 4 pounds; water, 15 gallons. Dissolve the alum and mix the two solutions thoroughly in a clean barrel or other suitable container and immerse the canvas, keeping it under the surface of the fluid for twelve to twenty-four hours. Then hang up to dry without wringing. The white powder (sulphate of lead) will shake off for a few days afterward.

THINGS WORTH KNOWING

Camp bread is easily made by the Lake Superior rule: One spoonful of baking powder for each cup of flour, with one spoonful of salt for the batch. Mix in water with the least possible stirring and bake quickly.

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The danger of explosion from gasoline is due to its vaporization and mixture with the right proportions of air. The liquid gasoline burns like kerosene or any other product of petroleum, and the flame only causes trouble under the special condition mentioned. Gasoline exposed to the air will vaporize and naturally diffuse in the atmosphere, and it is at such times that we are apt to hear of a funeral.

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The air-cushion automobile invented by Josef Hofmann, the pianist, and constructed at the Saurer Machine works, in the consular district of St. Gall, Switzerland, promises to bring about a revolution in automobile construction. In place of the usual steel springs, it has four brass cylinders for compressed air resting on the axles under the four corners of the automobile body, and these, by means of pistons and soft leather diaphragms, greatly reduce the swaying and jolting.

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To mark inscriptions on metals, take one-half ounce of nitric acid and one ounce of muriatic acid. Mix, shake the mixture, and it is ready for use. Cover the place you wish to mark with melted beeswax; when cold, write your inscription plainly in the wax clear to the metal with a sharp instrument; then apply the mixed acids with a feather, carefully filling each letter. Let it remain from one to ten minutes, according to the appearance desired; then throw on water, which stops the process, and remove the wax.

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For some 2,000 miles the Colorado river sweeps diagonally across the country from the high mountain plateau of Wyoming and Colorado to the farthest southwest corner of the United States. The basin drained by the Colorado and its tributaries is about 300,000 square miles in area. The control of the Colorado for the prevention of further outbreaks, such as its recent diversion into Salton sea, must involve thorough knowledge of the tributary flow, even in the high regions of its headwaters, in Colorado, and the ultimate steps taken to prevent disastrous inundations will, in all probability, involve the control of these upland tributaries. The size of the Colorado river is indicated by its discharge at Yuma in the year 1910. The heaviest discharge was in May, 70,300 cubic feet a second; the smallest discharge in October, 4,300 cubic feet a second. The total run-off for the year was 14,300,000 acre-feet, which would make a lake 1,000,000 acres in extent and 14.3 feet in depth.

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To make rubber packing air and steam tight, brush it over with a solution of powdered resin in ten times its weight of strong water of ammonia. This mixture when first made is unfit for use, but in three or four weeks it readily adheres to rubber as well as to wood or metal and becomes absolutely impervious to liquids. A good cement for joints in steam or water pipes, and, which will set under water, is composed of 4 pounds paris white, ground; 10 pounds litharge, ground; ½ pound yellow ochre, fine; ½ ounce hemp, cut short. Mix well with linseed oil to a stiff putty.

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From time to time during the last six years the United States has made analyses of a large number of samples of coal collected by geologists from various states and fields. Most of the samples were taken in anticipation of the publication of a geologic report on the field from which they were obtained, but for various reasons the preparation of the several reports has been greatly delayed, and some of them have been postponed for consolidation with reports on other areas. In view of the fact that the analyses are valuable to persons interested in the fields from which the samples were taken, the Geological Survey has published the data for more than 160 of these samples in Bulletin 471-J.

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The "continental horsepower," which is used on the continent of Europe, differs from the English and American horsepower by more than 1 per cent, its usual equivalent in watts being 736. This difference is historically due to the confusion existing in weights and measures about 100 years ago. After the metric system had come into use in Europe, the various values of the horsepower in terms of local feet and pounds were reduced to metric units and were rounded off to 75 kilogram-meters per second, the English values being equivalent to 76.041. The bureau of standards of the United States has adopted 0.746 kilowatt as the exact equivalent of the English and American horsepower.

When the Stamp Mill Sounds Its Call

By AL. H. MARTIN

When the old stamp mill is roaring and the blasting shakes the hills,
And you hear the iron lyrics of the hammers and the drills,
When the clanging pumps commingle with the old compressor's song,
And you watch the mule-teams straining as they tote the ore along,
And you see your partners toiling as all honest partners should;
Then you ken Achievement's glory, and you know that God is good.

There's the call of fierce Endeavor in the thrilling mountain air,
Spurring on to deeds of boldness—calling all to do and dare.
Death lies grinning in the shadows where the mountain hoards its gold,
But the magic gold is calling, world-controlling, uncontrolled,
Calling fearless men to claim it—calling men of brawn and brain;
Not the puny souls of weaklings—and it hath not called in vain.

In this land of hearts of lions you're a man because you are,
Not because you father's father struck it rich on Fortune's Bar.
And the same mill sounds the sonnet of the mountains' laws and creeds.
Soulless words are naked nothings—men are measured by their deeds.
And the game is to the fearless and the nuggets to the bold,
For each man builds on his mettle 'mongst the seekers of the gold.

LEACHING APPLIED TO COPPER ORE* (XXIII)

SULPHATIZING OF CUPRIFEROUS MATERIAL BY ROASTING

By W. L. AUSTIN*

Warlimont has published in "Metallurgie" (the February issues of 1909) an article descriptive of roasting tests carried out by him, which contains much of interest from the view-point of copper hydrometallurgists. The object of Warlimont's investigation was to discover a method of beneficiating nickeliferous pyrrhotite which should be superior to those now in use. It is well-known that the nickel of commerce is at present mainly produced by the "Orford," or the "Mond" processes; but much secrecy has been maintained regarding the costs of handling ore by these methods, and it is assumed to be high because of extensive manipulation.

Nickel in nature is usually associated with copper and iron, so that treatment of its ore involves separation from both these metals. The Orford process accomplishes this result by repeated meltings of the associated sulphides with sodium sulphate and charcoal, whereby a complex matte containing iron, copper and alkali separates from, and floats on the top of, a more or less pure nickel sulphide. In the Mond process a current of carbonic oxide is passed over the nickeliferous material, nickel is volatilized as nickel carbonyl, and this compound is then decomposed by heat. With both processes the operation must be repeated a number of times to effect satisfactory separation of the metals.

In the article referred to, Warlimont proposes a wet method of treatment, wherein the sulphides are first given a sulphatizing-roast, and then leached. Based upon tests made by himself, he outlines a process by means of which a nickeliferous pyrrhotite can be treated so that nearly all the copper is converted into soluble sulphate, the iron into insoluble feric oxide, and the nickel for the most part remains in the original sulphide form. To bring about this result he shows that the following is essential: (1) a roasting temperature must be maintained between 450° and 480° C.; (2) this temperature must be raised during the latter part of the operation to about 550° C.; and (3) the admission of air to the roasting furnace must be under full control, so as to avoid over-heating the charge through too rapid combustion of the sulphides themselves.

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Warlimont's tests were carried out in a thoroughly scientific manner and he makes out a strong case in favor of his process. Of course, tests made on small batches of ore have always to be confirmed by a continuously operating plant before they attain commercial value. The sulphatizing-roast data furnished by Warlimont are not only applicable to the beneficiation of nickeliferous pyrrhotite, but are equally important in considering the metallurgical treatment of other copper-sulphide ore. Because of the many failures which have occurred, precisely in the roasting department, it is manifestly of interest to learn how chalcopyrite ore has been roasted so that ninety-odd per cent of the copper was leached out with acidulated water, and Warlimont's methods of accomplishing this will be discussed in the following. Any one especially interested in the separation of nickel from its combinations with sulphur, iron and copper, is referred to the original paper.

TEMPERATURES AT WHICH METALLIC SULPHATES DECOMPOSE.

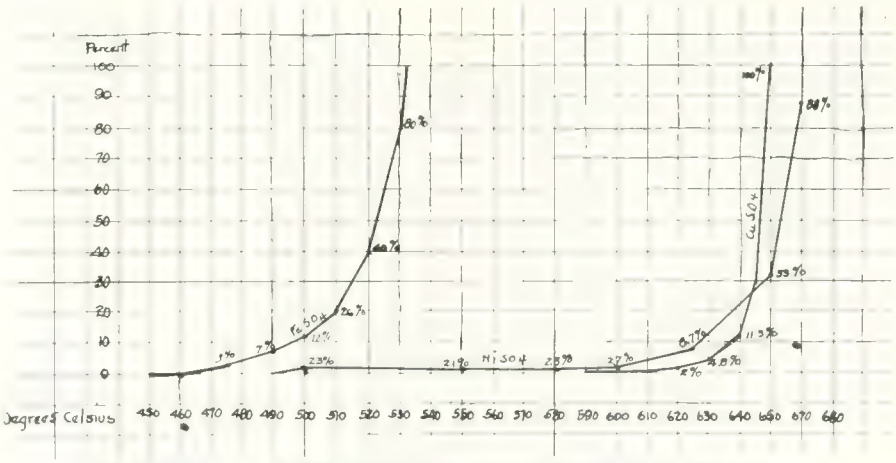
In some preliminary experiments it was found that the temperature at which nickel sulphate decomposes is about the same as that at which copper sulphate breaks down, and that the first named salt is little, if any, more stable in the roasting-furnace than the latter, which fact is contrary to the statements of at least one prominent writer. At 600° C. nickel sulphate is said to be wholly unaltered, but at 650° the sulphates of both nickel and copper rapidly disintegrate.

With regard to the temperature at which copper sulphate decomposes, the following experiments, carried out upon a small scale, are recorded:

Some copper sulphate was dried at 250° C., and then analyzed 39.81 per cent copper and 59.87 per cent SO_4. When this material was heated at temperatures below 600° C. there was no decomposition, but at this temperature separation of the components of the salt gradually commenced, and increased rapidly at 650°. After roasting for three hours, the respective quantities of $CuSO_4$ decomposed at gradually ascending temperatures were:

Temperature.	Per Cent $CuSO_4$ Decomposed.
600° C.	Traces.
610	"
620	2.0
630	4.8
640	11.3
650	100.0

With nickel sulphate decomposition set in somewhat earlier, and it appeared that



Decomposition Temperatures of Sulphates, according to Warlimont.

the temperature at which this salt forms is not far from that at which it decomposes. The material used analyzed 64.1 per cent SO_4, and contained some free acid which may account for results obtained at temperatures below 600° C. Free sulphuric acid decomposes readily at 500° C.

After roasting for three hours, tests made with nickel sulphate showed:

Temperature.	Per Cent $NiSO_4$ Decomposed.
500° C.	2.3
550	2.1
580	2.3
600	2.7
625	8.7
650	33.0
670	88.0

For sake of comparison, the results obtained in treating ferrous sulphate in a similar manner are also included. When this salt is roasted in an air-current, following decompositions are thought to take place:

$6FeSO_4+3\ O=2Fe_2(SO_4)_3+Fe_2O_3$

$Fe_2(SO_4)_3 = Fe_2O_3 + 3SO$

$SO_3 = O + SO_2$

The roasting period was here also three hours, and the amount of ferrous sulphate decomposed at different temperatures is given as follows:

Temperature.	Per Cent $FeSO_4$ Decomposed.
450° C	Traces.
460	"
475	3
490	7
500	12
510	20
520	40
530	80
550	100

The temperatures at which the sulphates of copper and iron form, when their respective sulphides are given a sulphatizing-roast, are shown in the table below. The material used in these two roasting experiments contained respectively 76.2 per cent copper (Cu_2S) in the case of the copper test, and 63.5 per cent iron with 36.0 per cent sulphur, in the iron test. The temperature at which the iron sulphide was roasted ranged from 420° to 430° C.; that used in handling the copper sulphide, between 420° and 440° C.

Hours.	Per cent $FeSO_4$ formed.	Per cent $CuSO_4$ formed.
3	11.0	34.00
3.5		39.78
4	15.6	42.04
5	20.2	

It is seen from the table that $CuSO_4$ was produced more quickly and easily than ferrous sulphate. Only traces of nickel sulphate were found to form at temperatures below 600° C.

Measurements of furnace temperatures in all the tests were made with the help of an electric pyrometer connected with a milli-voltmeter.

IRON ASSISTS IN FORMATION OF SULPHATES.

Whereas it had previously been thought that the presence of iron interfered with the economical separation of nickel and copper, and therefore it was best to start with a concentrated matte, Warlimont showed by his experiments that iron exerts a beneficent influence when roasting for sulphates, in that it acts as a transferrer of oxygen, and with its help nearly all the copper can be leached out from a properly roasted pulp with acidulated water. At the same time the iron content of the lixivium can be so reduced by regulating the furnace temperature while roasting that it does not cause trouble in subsequent operations.

The following experiments indicate the influence of FeS on a sulphatizing roast. It is seen that varying quantities of FeS were roasted with identical amounts of Cu_2S, to ascertain the proportions producing best results. In the first experiment just sufficient FeS was present to furnish the sulphur necessary to bring all the copper into sulphate form.

$2Cu_2S+2FeS+19\ O = 4CuSO_4+Fe_2O_3$

The roasting lasted three hours at about 450° C., and was afterwards raised to 530° to 550°. In this manner it was found possible to bring 83 per cent of the copper into sulphate form, with 3.1 per cent of the iron also as sulphate. There were only traces of sulphides left in the residue.

No. of experiment.	Parts Cu_2S.	Parts FeS	Pr. Ct. Copper Sulphate form.	Pr. Ct. Iron Sulphate form.
1	1	1	83.00	3.10
2	1	2	92.25	4.87
3	1	5	95.40	....
4	1	10	96.70	....
4 (repetition)	1	10	97.50	....

The leaching was done with water to which had been added sufficient hydrochloric acid to bring into solution any basic sulphate which might have formed.

The foregoing tests were carried out with small quantities of simple sulphides to obtain direct experimental data with regard to temperatures at which the respective sulphates form, and again at which they disintegrate. In the following tests larger amounts of material were employed, and constitute a laboratory demonstration of the working of the proposed new process for beneficiating nickeliferous pyrrhotite. The ore used in these tests was pulverized magnetic pyrites (pyrrhotite), so fine that it passed through a screen of fifty meshes to the running inch. Analysis showed the composition of these pyrites to be:

Sulphur	25.25 per cent
Iron	42.40 " "
Copper	0.7 " "
Nickel	3.10 " "
Silica	13.11 " "

The furnace employed was an ordinary muffle, gas heated, with a hole knocked in the back end so as to obtain good circulation of air.

The following experiments were made to ascertain the temperature best suited, and the length of time necessary, to bring the largest amount of copper into leachable form. In the first experiment the temperature was held for twelve hours at about 450° C. The resulting extraction of copper from the roasted pulp by water was:

After 4 hours 37.3 per cent copper.
" 10 " 60.0 " " "
" 12 " 73.3 " " "

In this experiment, as well as in those following, about two drops of sulphuric acid were added to each 300 cc. of the water used in leaching the roasted pulp.

The second experiment was conducted in the same manner, only the roasting temperature was maintained for four hours at 450° C., and then raised to 500°. The extraction was:

After 4 hours 40.0 per cent copper.
" 8 " 79.5 " " "
" 12 " 89.0 " " "

The temperature in the third experiment was held for four hours at 480° C., and after eight hours raised to 500°. The extraction was:

After 4 hours 39.0 per cent copper.
" 8 " 80.0 " " "
" 12 " 96.3 " " "

In the fourth experiment the roasting was carried on for 16 hours at 480° C., and the extraction was:

After 4 hours 45.0 per cent copper.
" 8 " 88.3 " " "
" 12 " 97.0 " " "
" 16 " 96.9 " " "

Of the nickel hardly more than ten per cent of that contained in the original ore was dissolved by the aqueous solution, and by raising the roasting temperature to 550° C., the iron content of the lixivium was reduced to a point where it gave no trouble in the following work. However, when the temperature was raised above 550°-600° C., the percentage of copper extracted slowly receded.

BEST ROASTING TEMPERATURES FOR SULPHATIZING COPPER.

It was apparent from these experiments that the best roasting temperatures for effecting sulphatization of the copper in the ore in question, was 480° C.; but it was also found that a large amount of iron went into solution. This was particularly the case in the first experiments, after the pulp had been roasted four and eight hours. When, however, the temperature was raised after formation of the copper sulphate was completed, then the greater part of the iron passed over into insoluble form without copper sulphate being decomposed.

The progressive formation of ferric oxide (Fe_2O_3) is disclosed by the changing color of the pulp. At first this was blackish-grey, which altered to a dirty red-brown after about six to eight hours. With continuous roasting for about 12 hours, or when the temperature is raised, the pulp takes on a beautiful red color, due to formation of insoluble ferric oxide, and the most of the iron is then found to be in the insoluble state.

To ascertain the relative amounts of copper, nickel, and iron going into a

soluble form at varying temperatures and roasting periods, a further series of tests was undertaken. In these the percentages of iron and nickel are given in terms of copper.

Experiment No. 1.—The ore was roasted for 12 hours at a temperature of 480°C. The copper extraction was 95.6 per cent. The lixivium contained 23 parts nickel, and 440 iron, for every 100 parts copper.

Experiment No. 2.—Raising the temperature to 500° C., and roasting for 10 hours, gave an extraction of 96 per cent of the copper, and the relative amounts of nickel and iron in the lixivium were respectively 35 parts nickel and 230 parts iron to 100 parts copper.

Experiment No. 3.—Eight hours roasting at 480° C., followed by four hours at 800°. Copper extraction 94.5 per cent. Relative proportions of metals in the lixivium: 100 copper; 37 nickel; 103 iron.

Experiment No. 4.—Ten hours roasting at 480° C.: four hours at 550°. Copper extraction 96.7 per cent. Metal content of lixivium: 100 copper; 53 nickel; 67 iron. Repetition of this experiment gave 96.3 per cent extraction. The livivium contained: 100 copper; 45 nickel; 53 iron.

Experiment No. 5.—Nine hours roasting at 480° C. Then temperature raised to about 600° for three hours. Copper extraction 92 per cent. Lixivium: 100 copper; 63 nickel; 32 iron. This experiment repeated gave: copper extraction 94.5 per cent. Lixivium: 100 copper; 51 nickel; 45 iron.

From data contained in the above experiments, it appeared inadvisable to raise the roasting temperature above 550 C., because at higher temperatures copper extraction was shown to be less complete, and more nickel went into soluble form. As some of the iron in the roasted pulp remained as ferrous salt, two experiments were then made to ascertain the effect of allowing this ferrous salt to oxidize in the air, and of employing the resulting ferric sulphate as lixiviant for that portion of the copper content of the pulp which had remained insoluble in an aqueous solution of the strength previously used.

In carrying out this test two batches of pulp were roasted, and then both were kept moist, and stirred often during the ten days that they were exposed to the air. They were then lixiviated. In these tests the following results were obtained:

COPPER EXTRACTION.

First Test—

Before air oxidation:
73 per cent copper.
100 Cu; 22 Ni; 430 Fe.
After air oxidation:
87.5 per cent copper.
100 Cu; 19.5 Ni; 225 Fe.

Second Test—

Before air oxidation:
89 per cent copper.
100 Cu; 43 Ni; 289 Fe.
After air oxidation:
96.5 per cent copper.
100 Cu; 40 Ni; 87 Fe.

A third batch of pulp was roasted so that 94.7 per cent of the copper was extracted by acidified water, and then the pulp was treated as in the last two tests by exposing it to air in a moist condition and repeatedly stirring. The soluble copper content then rose to 95.3 per cent, and the relations of the metals in the lixivum were:

Before air exidation:
100 Cu; 32 Ni; 61 Fe.
After air oxidation:
100 Cu; 31 Ni; 46 Fe.

Other tests were made in which the roasted pulp was exposed to the air for longer periods; but the results given above were not materially changed.

The explanation offered for the fact that an additional amount of copper went into solution by exposing the moistened pulp to air, is, that in an insufficiently roasted material there are present a number of not fully oxidized copper combinations which are insoluble in acidified water, but are oxidized and dissolved by ferric sulphate resulting from oxidation of the ferrous salt. Among such compounds of copper which are insoluble in weak solutions of sulphuric acid are the sulphides of copper (Cu_2S and CuS) and cuprous oxide (Cu_2O).

SUMMING UP RESULTS OF FOREGOING EXPERIMENTS.

Summing up the results of the foregoing experiments it is seen that when roasting has been properly conducted 97 per cent of the copper content of a magnetic pyrite can be brought into the form of soluble sulphate, while barely ten per cent of the nickel is taken up by the solvent. To obtain these results there must be an adequate amount of iron sulphide present in the ore. Any ferrous or ferric sulphate that forms in the roasting is converted for the most part into oxide.

With regard to the proper style of furnace in which the sulphatizing results given in the foregoing might be obtained upon a commercial scale, Warlimont recommends a revolving drum, closed at both ends so as to prevent escape of dust. In such a furnace the temperature can be kept under strict control, which item has been shown to be essential to success. From a series of sulphur dioxide determinations made, (which are given in the original paper), it was determined that a plant equipped with two such furnaces would furnish gas of proper constituency for the manufacture of sulphuric acid.

Reference is also made to the leaching works at Predazzo in southern Tyrol, where a furnace of this description was in commercial operation. This furnace at Predazzo (described in "Metallurgie" 1909, page 581) put through between four and five metric tons of ore in 24 hours, the sulphatizing roast being carried to such a point that 96 per cent of the copper was in soluble form.

It is also recommended that comminution of the ore be not carried too far. It was found that a satisfactory roasting and lixivation was obtained when a screen was used with less than 25 meshes to the running inch. With material of this size from two to three per cent of the sulphur remained in the pulp after leaching, and this was almost entirely combined with nickel. When a coarser grained material was treated, the copper extraction fell off notably, and the sulphur content rose to seven per cent. In charging the leaching vats it is recommended that the lixiviant be introduced through the filter-bottom while the roasted material is being placed in the vat, so that it may become evenly moistened. When the vat is three-quarters full, and the lixiviant has risen to the top of the vessel, ingress of the liquor should be stopped, and direction of flow reversed. With roasted material of suitable size, it is stated that no difficulty was met when drawing the lixivium off through the filter-bottom.

Warlimont also furnishes figures relative to cost of plant designed for using his method, as well as cost per ton of ore treated. The proposed plant was designed for treating an ore in Norway, and the machinery was to be of German manufacture. It was proposed that the works should handle 22,000 tons (@2,000 lb.) yearly, and the cost of power is given at $7.50 (30 Marks) per horsepower-year. In the following estimate the Mark is taken as the equivalent of 25 cents, and those items which refer only to the nickel end of the business are omitted.

COST OF PLANT.

Crushing machinery	$ 16,500
Roasting department	15,000
Refractory building material	4,250
Leaching department	4,125
Sheds	1,875
Cementation	5,000
Laboratory	2,500
Wooden buildings (one-half)	6,250
	$55,500

COST OF TREATMENT.

	Per Ton.
Crushing	$ 0.750
Roasting	0.625
Transportation	0.050
Leaching	0.100
Drying	0.0375
Cementation (inclusive iron)	0.2500

Wages @ $0.875 per diem (one-diem)	0.6375
Salaries and laboratory	0.3000
Repairs and renewals	0.0750
	$2.8250

As the crushing was only carried to 25 mesh, this item of expense ($0.75 per ton) seems unduly high. The wages are low, but the number of employes (150) is very great. Power is, of course, extremely low. A point of special interest in this estimate is the specific cost of leaching, which is figured at $0.10 per ton of nickeliferous pyrrhotite.

If an ore carrying 2.5 per cent copper were treated by this method, with ninety per cent extraction, according to Warlimont's estimates, the cost per pound copper would be $0.064. This, however, does not include costs of mining, interest on investment, nor amortization, and leaves the copper in form of precipitate. In most cases electrolytic copper could be produced for the same figure or less.

Conditions Affecting The Value Of Gold

By JAS. O. CLIFFORD*

The attempt to answer this question in a satisfactory manner has engaged the attention of economists more than any other problem in pure theory, and, while much has been accomplished theoretically, many knotty problems have been presented which, in practice, precludes a clear understanding of the subject. However, in briefly outlining the subject, it is the intention of the writer to present only those points which have been exhaustively discussed by the world's greatest political economists, and which points have a direct bearing upon the question in hand. The works of Mill, Walker, Jevons, Cairnes, Nicholson, and others, have been consulted, and due credit is given each author where excerpts from the original treatises have been used. It should be understood by the reader that no attempt to treat the subject in its entirety is at all contemplated by the writer, and where further information is required on any particular question I need only refer him to the standard works on the subject of political economy.

Before considering the causes determining the value of gold, it will first be necessary to briefly review the general laws of value, and, therefrom it will easier to understand the subject.

Production is the most fundamental of the laws of value, the requisites therefor being three, viz., (1) labor, (2) appropriate natural objects, and (3) capital. The product resulting from the action of those three forces is then considered as having an inherent value, which term implies at least two meanings—value in use, and value in exchange. However, the conception of utility is the most fundamental in economics, and while value in use is obviously much wider in its application than value in exchange, it should always be understood that by value in political economy is meant value in exchange. In this connection, however, exchange value requires to be distinguished from Price. Writers employed Price to express the value of a thing in relation to money—the quantity of money for which it will exchange. By the price of a thing, therefore, is understood its value in money; by the exchange value of a thing, its general power of purchasing, or, more clearly, the command which its possession gives over purchasable commodities in general. Therefore, one who talks of the exchange value of anything means the number of dollars, pounds sterling, and soforth, which it will bring in the market. On this view then the value of a thing is its price. There is such a thing as a general rise of prices, (all commodities may rise in their money price) but there cannot be a general rise of values. If one-half of the commodities in the market rise in exchange value, the very term implies a fall of the other half; and, conversely, the fall implies a rise. This line of argument leads to the position: "The idea of general exchange value originates in the fact that there really are causes which tend to alter the value of a thing in exchange for things in general; that is, for all things that are not themselves acted upon by causes of similar tendency." Following out this idea Mill proceeds to say that any change in the value of one thing compared with things in general may be due either to causes affecting the one thing or the large group of all the other things, and that, in order to investigate the former, it is convenient to assume that all commodities but the one in question remain invariable in their relative values. On this assumption any one of them may be taken as representing all the rest, and thus the money value of the thing will represent its general purchasing power. That is to say, if for the saks of simplicity we assume that the prices of all other things remain constant, but that one thing falls or rises in price, the fall or rise in price in this thing will indicate the extent of the change in its value compared with things in general.

REQUISITES FOR VALUE.

The theory of value is essentially an examination of the causes which determine the value of particular commodities relatively to a standard which is assumed to be fixed. Therefore, in order that anything may possess value in this sense, that it may exchange for any portion of standard money, or its representatives, it is evident that two conditions must be satisfied. First, the thing must have some utility; second, there must be some difficulty in its attainment; the difficulty of attainment, however, sometimes consists in an absolute limitation of the supply. In this connection it is interesting to note that there are some articles of which the supply may be indefinitely increased, but cannot be rapidly diminished. There are things so durable that the quantity in existence is at all times very great in comparison with the annual production, among which are platinum, gold, silver, and other durable metals. The supply of such things might be at once diminished by destroying them; but to do this could only be to the interest of the possessor if he had a monopoly of the article, in which event he could repay himself for the destruction of a part thereof by the increased value of the remainder. The value, therefore, of such things may continue for a long time so low, either from excess of supply, or falling off in demand, as to put a complete stop to further production; the dimunition of supply by wearing out being so slow that a long time is requisite, even under total suspension of production, to restore the original value.

LAW OF SUPPLY AND DEMAND.

Demand is defined as the quantity of any article demanded at some particular price, in which instance the one demanding the price can readily meet his engagements; in other words, there must be what is termed an effectual demand.(4) Further, by demand it must not be assumed simply as a desire to possess, because in a sense everyone desires everything and the less the mean of payment, so much greater in general is the desire. Also, it is absolutely necessary to insert the qualifying clause "at some particular price," because, as a general rule, with

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Notations:
(1) Mill, J. S., Political Economy.
(2) [illegible] Political Economy.
(3) Walker, F. A., Money.
(4) [illegible] J. S., Political Economy.

a change in price a different quantity will be demanded. In fact, the variation of quantity demanded, according to variation in price, is that which gives rise to the statement of the general law of demand which is: That as the price of any article falls, other things remaining the same, the quantity demanded increases, and, conversely, as the price rises, the quantity demanded decreases.

Supply in a similar way may be defined as the quantity offered for sale at some particular price. As the price rises, other things remaining the same, the quantity offered tends to increase, and conversely, as the price falls, the quantity offered tends to diminish. From which it follows that, as a general rule, things tend to exchange for one another at such values as will enable each producer to be repaid the cost of production with the ordinary profit. It is, therefore, apparent that the latent influence by which the value of things are made to conform in the end to the cost of production is the variation that would otherwise take place in the supply of the commodity; that is, the supply would be increased if the thing continued to sell above the ratio of its cost of production, and would be diminished if it fell below that ratio. This considers that the value of a thing is proportional to its cost of production, and by this is meant the point to which it always tends to return, the center value toward which the market value of a thing is constantly gravitating; and any deviation from which is but a temporary irregularity which, the moment it exists, set forces in motion tending to correct it.

COST OF PRODUCTION.

The component elements of cost of production are labor and capital acting by natural forces upon raw material; but, since both the forces and the produce of nature require labor and capital for their exploitation, the elements that must be considered fundamental in the case of commodities that can be indefinitely increased are labor and capital. Capital is itself a product of labor. It is apparent, therefore, that, in order that a thing may be continuously produced, labor must obtain a sufficient reward for its toil, and capital a sufficient reward for preservation and the accumulation of wealth. It is a necessary condition of the production of any article that the price obtained will yield the necessary wages, and a fair profit for that species of work. These rates of wages and profit can be, as generally they are, stated in terms of money, and it is at this point that the difficulty emerges as to the precise nature of the connection between the prices of commodities and the money wages and profits of producers. It follows that, if all commodities were produced directly by the expenditure of labor, and in such a way that capital need not be considered, then the only element to consider in value would be the quantity of labor. And, in a more highly developed state of society in which wages were paid, if we consider that the rate of wages is uniform, and that the profits may be disregarded in comparison with wages, the quantity of labor is the most important consideration, and a decrease in the relative value of any article can only take place through some economy in labor.

However, as we approach the actual constitution of modern industrial societies we observe more serious differences in the rates of wages in different employments, the use of fixed capital becomes of greater importance, and in some cases the lapse of time necessary for the completion of the commodity is considerable. Thus interest and profits, as well as the differential rates of wages have to be taken into account just as much as the quantity of labor, and it is generally convenient to consider also the established differences in various returns to capital under different conditions. Indirectly, of course, since all capital in the ordinary sense is the result of labor, the quantity of labor is always of primary importance, but, in considering the cause of relative values, it is always best to consider capital and labor as independent factors.

When comparing the relative values of two commodities, however, we should take into account the relative wages and relative profits, and the relative amounts of capital and labor employed in their production. Obviously any change in the relative wages and profits will affect the relative values, and, if the proportions are different in which labor and capital are employed in the production of any two commodities, then any change in the general rates of wages and profits will affect relative values. Hence two important practical conclusions of a general character have been drawn: (1) Relative values are liable to constant disturbances, and accordingly, since relative prices tend to be adjusted to relative values, relative prices must be constantly changing. (2) It is extremely difficult to measure changes in the value of the monetary standard, or movements in the general level of prices, or variations in the purchasing power of money.

VALUE OF MINING PRODUCE.

The value of mining produce is determined generally in the same manner as that of other commodities, but similar qualifications must be introduced. The theory is that both extensively and intensively the produce of mines is subject to the law of diminishing return, that the margin recedes as the price falls and extends as it rises, and that thus the price is determined by the most costly portion which it just pays to market. In general the produce of mines is, like that from many other sources, consumed in a comparatively short time, and thus the value is subject to fluctuations according to the conditions of the annual demand and supply. The peculiar durability of the precious metals, however, makes them in this respect differ widely from most mining produce. Therefore, it is of course undeniable that, supposing coinage free, the value of standard coins will be equal to the value of the same amount of bullion, and, conversely, that the bullion will be equal in value to the same amount of coins.

The older economists argued that the precious metals had their value determined by their cost of production under the most unfavorable circumstances, and then argued that in consequence the value of money tended to be governed by the cost of production of bullion. If, however, it is remembered that the annual production does not probably amount to but a fractional part of the quantity in the hands of man, that cost of production can only operate through actual or potential supply, and that in the case of money the increase must be real to affect prices, it will readily be seen that the value of bullion is determined by the general level of prices (or the value of money), and not that the value of money depends upon the value of bullion. At the same time, however, it is true that, if prices become very high (in other words, if the value of money, and thus of bullion, becomes very low), then a check is placed upon production from the mines, and, conversely, with falling prices, or a rise in the value of the precious metals, mining for them is extended and encouraged. On the whole, this case of the precious metals furnishes perhaps the best example of the way in which the cost of production can only act through the law of supply and demand.

From the foregoing it is quite apparent that, in order that the value of gold be more clearly understood, we must consider the relation, in brief, between the actual production of precious metals as bullion, and the causes which have led to the adoption of a monetary system and the operation of the latter.

MONEY.

The clearest definition of money is that given by Walker as being 'That which passes freely from hand to hand throughout the community in final discharge of debts and full payment for commodities, being accepted equally without reference to the character or the credit of the person who offers it, and without the intention of the person who receives it

to consume it or to enjoy it or apply it to any other use than in turn to tender it to others in discharge of debts or payments for commodities."(3). Therefore, the most important function of money is that of affording a ready means of estimating the comparative value of different commodities, and, it is apparent that, without some common commodity as a standard of comparison, this would be impossible. Hence, according to Jevons, "The chosen commodity becomes a common denominator, or common measure of value, in terms of which we estimate the value of all other goods."(2)

Another equally important function of money comes into being with the increase in relations of contract. As a contract implies something to be done in the future there must be some means of estimating the value of that future act, therefore, a standard is required; and here money, which already acts as a medium of exchange, and as a measure of value at a given time, performs a third function by affording an approximate means of estimating the present value of the future act, and in this respect may be regarded as a standard of value of deferred payments. Summarized, the function of money are: (1) the common medium by which exchanges are rendered possible, (2) the common measure by which the comparative values of those exchanges are estimated, and (3), the standard by which future obligations are determined.(4) The causes which determine the value of money is a particular case of the general problem of values. As remarked in a previous paragraph, "the value of a thing is what it will exchange for; the value of money, therefore, is what money will exchange for, or its purchasing power. If prices are low, money will buy much of other things and is of high value; if prices are high, it will buy but little of other things, and is low of value.—Mill."

In considering the terms supply and demand as applied to money it is interesting to note that, while the supply of any commodity means the quantity of it which is offered for sale, and the demand for a commodity is the purchasing power offered for it, supply in the case of money means all the money in circulation at a particular time, and demand in the special case of money consists of all the goods offered for sale. From the peculiar feature in the case of money, which arises from its position as the medium of exchange (that is, that it is in a constant state of supply and demand) it follows that the factors which determine the value of money within a given time are: (1) the amount of money in circulation, and (2) the amount of goods to be sold Furthermore, in determining the value of money the varying rates of circulation (efficiency of money—Mill) have to be considered, and on the side of demand, it is not the quantity of commodities that is the determining element, but the amount of sales. In this connection it also should be observed that, in addition to commodities, services of all kinds, payments of interest on various forms of obligations, and the influence of credit must also be considered as exerting a tremendous influence on the value of money. Further, the value of money as stated by Mill, is inversely as its quantity multiplied by what is called the rapidity of circulation. The essential point is, not how often the same money changes hands in a given time, but how often it changes hands in order to perform a given amount of traffic. The comparison should be made by the number of purchases made by the money in a given time, not with the time itself, but with the goods sold in that same time.

It is plainly evident, however, that the mere introduction of a particular mode of exchanging things for one another, by first exchanging a thing for money, and then exchanging the money for something else, makes no difference in the essential character of the transactions, for the reason that it is not with money that things are really purchased. Nobody's income, except that of the precious metal miner, is derived from the precious metals constituting money. The money which a person receives is not what constitutes his income; it is merely an order which he can present for payment at any shop he pleases, and which entitles him to receive a certain value of any commodity that he desires. There is no clearer explanation of this feature outlined than that given by Mill in which he states that payments are made in money as the most convenient plan for those concerned, and, when a master pays his servants in money he is merely giving them their share of his property for services rendered, and it makes no essential difference whether he distributes their real income in shares of his property, or whether he sells it for them and gives them the price. In fact, there is not, intrinsically, a more insignificant thing than money, except in the character of a contrivance for sparing time and labor.

The introduction of money does not interfere with the operation of any of the laws of value The reasons which make the temporary or market value of things depend on the demand and supply, and their average and permanent values upon their cost of production, are as applicable to a money system as to any other system. The relations of commodities to one another remain unaltered by money. Money is a commodity, and its value is determined like that of other commodities, temporarily by demand and supply, and on the average, by cost of production. The value of money, then, conforms permanently to the value of the metal of which it is made; with the addition, or not, of the expenses of coinage, according as those expenses are borne by the individual or by the state.

THEORY OF INTERNATIONAL VALUES.

The discussion which has repeatedly taken place on the question as to whether a distinct theory of international values is required is best explained by making clear the assumptions on which the values of commodities produced within a nation are determined, and then considering the changes which must be made when we bring in other nations. Briefly, a nation in the sense of the present use of the word might perhaps be more advantageously described as a place wherein there is effective industrial and commercial competition—more satisfactorily termed an economic area. The application of effective industrial and commercial competition to international trade is equally as apparent as though but one economic area were considered, for, so soon as trade is established the commodities will sell for the same price in all other countries into which it is imported—due allowances being made for cost of carriage, and other incidental charges. If there is any real difference between domestic and international values, it must arise owing to the absence of effective industrial competition; that is to say, in the same economic area the real cost determines the expenses of production.

It thus follows that a country may import articles which it could produce at less real cost, provided that it pays for these imports with exports that cost even less. According to this theory every country will devote its labor and capital to its most productive uses. It must, therefore, be assumed that in the absence of loans, tributes, and so forth, imports can in the long run only be paid for by exports, and also that those articles will be exported which can be produced at the least comparative cost. This theory then may be held to explain in a satisfactory manner the origin and development of international trade, but the question of values is still undetermined. Consistently with exports paying for imports many different rates of exchange are possible, and the particular rate actually adopted depends entirely upon reciprocal demand. And in extreme cases, in which new countries trade solely in articles of which each has a monopoly, this answer would seem to be correct; but, when we consider that under present conditions trading countries have many articles in common, and that a slight margin of profit

suffices to expand or diminish an export trade, this explanation seems too vague.

The most probable solution, therefore, seems to be that the rates of exchange will be so adjusted as to give to the exporters the ordinary rate of profit current in their respective countries. In general it is clear that the rate will be determined independently of the foreign trade, or at least that the foreign trade is but a factor to be considered. However, the following, known as the Equation of International Demand, fully explains the situation. "The produce of a country exchanges for the produce of other countries at such values as are required in order that the whole of her exports may easily pay for the whole of her imports."(4) This law of International Values is but an extension of the more general law of value.

VALUE OF GOLD.

The qualities necessary to fit any commodity for being used as money are possessed in nearly an equal degree by the metals, gold and silver. Some nations, have, therefore, attempted to compose their circulating medium of these two metals indiscriminately. There is an obvious convenience in making use of the more costly metal for larger payments, and the cheaper one for smaller. The mode most frequently adopted has been to establish by law a fixed proportion between the two metals, it being left to everyone having payments to make to pay in either the one metal or the other. In this connection if natural cost values always continued to bear the same ratio to each other, the arrangement would be unobjectionable. Gold and silver, though the least variable in value of all commodities, are not invariable, and do not always vary simultaneously. In view of general economic conditions in the mining and metallurgical industries, either gold or silver is at any time subject to violent fluctuations, in which event the value of the two metals relatively to each other would not agree with their rated proportion.

Suppose, for example, that gold rises in value relatively to silver, so that the quantity of gold in an American dollar is worth more than the quantity of silver in twenty (20) silver dollars. The result would be that all payments possible would be made in silver coin for the special reason that it would not be to the interest of the debtor to pay in gold. The converse of this would happen if silver, instead of gold, were the metal which had risen in comparative value. The money of a community, therefore, would never really consist of both metals, but of the one only which, at the particular time, best suited the interest of the debtors; and the standard of currency would be constantly liable to change from one metal to the other, at a loss on each change, of the expense of coinage on the metal which fell out of use. This is the operation by which is carried into effect the law of Sir Thomas Greshman to the purport that "money of less value drives out money of more value."

It appears, therefore, that the value of money is liable to more frequent fluctuations when both metals are a legal tender at a fixed valuation than when the exclusive standard of the currency is either gold or silver. The modern practice, however, considers the adoption of gold, the more costly metal, as a standard, and silver, while retained in circulation as a legal tender for small payments, is rated in comparison with gold, so that a turn of the market in its favor will not make it profitable to melt the silver coin. Further, overvaluation of the silver coin creates an inducement to buy silver and send it to the mint to be coined, thereby, receiving back a higher value than properly belongs to it; however, this has been guarded against by limiting the quantity of silver coinage, and by the enforcement of stringent regulations governing the relative ratios of silver to gold, which, while they have been changed from time to time in the United States, as well as in other gold standard countries, cannot, under any circumstances, be maintained contrary to the operation of the law of supply and demand.

We can readily assume an assigned constant price of $20.67 per Troy ounce of pure gold merely as a basis of the relative value of that commodity as compared to other commodities in general, or vice versa, but by no means does that price represent the actual value of the gold. In fact any arbitrary price which we might deem advisable to assign to gold would operate merely as a matter of convenience to ourselves and would, insofar as the actual value of metal is concerned represent nothing at all. Contrary to the general belief gold is subject to the same variations in value (although in a lesser degree) as all other commodities, but its variations while real are not so apparent as in the case of other commodities in view of the fact that we are in the habit of always making our comparisons on the basis of "value" of gold remaining at $20.67 per ounce, and all other commodities rising or falling in price relative thereto. Nothing could be more misleading and, generally, we should learn to consider every appreciation in the price of other commodities, as compared to gold, to indicate a corresponding depreciation of gold compared to those commodities. In fact, it is only along this line of reasoning that we can learn to fully appreciate the economic influence of the standard of currency. It should be remembered that gold, either as bullion, or as a coin having a designated "value" in the different countries, is no more than a commodity—just as sugar, rice, or any other like thing is a commodity—and that its exchange value is subject to similar variations,—dependent upon the law of supply and demand.

CONCLUSION.

While the subject could have been more extensively treated it is hoped by the writer than the brief outline above given will suffice to at least afford an insight into the general laws governing the value, not of gold only, but consistently of every other material thing with which mankind has to deal. The immutable law of compensation corrects everything of which the human mind can conceive. Just as the sea, it everywhere tends to a level; its surface is always ruffled by waves, and agitated by storms, but it is enough to point out that at least, no point in the open sea, is permanently higher than another. Each place is alternately elevated and depressed, but the ocean preserves its level.

From a report made by an "engineer," the following sentences are culled, says the Mining and Scientific Press: "The vein occupies a fissure of large extent horizontally and perpendicularly along the axes of an incline, with a strike north and south standing perpendicularly." * * * "Working of this mine consists of approixmately 8000 feet and a shaft 600 feet deep, originally operated as a tunnel to a depth of about 400 feet." Interesting food for reflection may be found in determining whether an incline "standing perpendicularly" is a greater natural wonder than a tunnel which has been plunged into the earth to serve as a shaft.

During August, the mints of the United States coined 25,101,000 pieces valued at $1,317,000, as follows: gold, 101,000 pieces worth $505,000; silver, 2,400,000 pieces worth $586,000; and copper (one cent) 22,600,000 pieces worth $226,000.

In testing oxidized gold ores, pulverize the sample in place in a porcelain lined vessel or tea cup, cover with iodine and allow it to stand from two to three hours. Then dip into it a piece of white filter paper, dry and burn it, and if it gives a purple color gold is present, and the deeper the purple the richer the ore. For other ores with this test, such as pyrites, the ore must be roasted. Where lime is present the ore must be roasted twice, the second time adding carbonate of ammonia. After roasting, test as with oxidized ores.

From Copper To "Gold Mines"

This space is reserved for the picture of A. F. Holden the other eminent engineer who lent his name and gave his endorsement to the electrifying report on Alaska properties submitted herewith and which will be reproduced from month to month.

NOTED ENGINEERS JOIN BROKERAGE HOUSE IN A REMARKABLY PECULIAR PRESENTATION OF AN ALASKA GOLD MIRAGE.

We have received a few inquiries from readers who wished to know why we did not publish all of the "report" of Messrs. Jackling and Holden of the Alaska Gold Mines Company instead of the following "extracts." In reply we wish to explain that, if there ever was anything more than these "extracts" made public we have ben unable to trace it. When Hayden, Stone & Co. sent out the letter inviting subscriptions to the stock they did it on the STRENGTH of the contents of these "extracts." Or that is the presumption, at least. That intending purchasers and investors at once became suspicious and have since kept hands off is indicated by the wording of nearly every line of publicity that has since been given the proposition. But read the "report" again. Here it is:

Extract From Report of Messrs. Jackling and Holden.

We have considered the PROBABLE capital requirements for a capacity of 6,000 tons per day, which contemplates a hydro-electric power plant; mine development and equipment, including all the necessary living quarters, both at the Perseverance mine proper and at the mill, and driving the long adit tunnel. We BELIEVE that $4,500,000 will do this work.

Our BELIEF is that the substantially INDICATED ore body is about 4,500 feet long by by seventy feet wide. The value of the 600,000 tons of ore THAT HAVE BEEN MINED FROM THIS BODY IN THREE DIFFERENT LARGE STOPES INDICATES that a recovery of at least $1.50 per ton can be made. We BELIEVE that there will be 75 cents per ton profit in this grade of ore. The Sheep Creek Tunnel, which will be driven on the vein as the main haulage level, will develop this ore body at an average depth of about 2,200 feet on the dip of the vein, or about 700 feet deeper than present developments.

The character of this vein is similar in A VERY GENERAL WAY to other large deposits of gold ore in the same vicinity in which the values at a vertical depth of 1,600 feet, or 2,000 feet on the dip of the vein from its apex, are practically the same today as they were on the surface, and have been throughout the development of THE DEPOSITS IN QUESTION. We visited these mines and saw THEIR deep levels, and, if there is any inference to be drawn from the continuity of THESE ore bodies, WHICH ARE NOT, HOWEVER, ON THE SAME VEIN AS THE PERSEVERANCE, one MIGHT BE TEMPTED to say that there is a PROBABILITY of ore 2,500 feet deeper than the so-called Sheep Creek Tunnel which we contemplate driving, BUT, while the PROBABILITY is there of the vein and values extending to great depth, THERE IS NOTHING TODAY TO WARRANT ANYBODY IN STATING THAT IT IS A FACT THAT SUCH WILL BE THE CASE.

There are substantially 50,000,000 tons in the ore body we consider definitely INDICATED. There is a PROBABILITY of another 2,000 feet to the east of the 4,500-foot ore zone previously mentioned, which, from surface indications, would seem FAIRLY CERTAIN to contain ore. Beyond this is some 1,800 feet of the vein concerning which we have NO FINAL OPINION one way or the other, AS WE VISITED NO WORKINGS OR OUTCROPS from which we could secure sufficient data to form accurate deductions. While we cannot at this time state that there IS ore here, there were several SMALL MINES worked almost at the extreme east end of the vein on this property, which INDICATES that this 1,800 feet will undoubtedly produce considerable ore and PERHAPS LARGE QUANTITIES. If we do not consider this in the PROBABILITIES, it is certainly well within the POSSIBILITIES.

This letter is based solely on a consideration of $1.50 recoverable value as ore. If one should figure on lower values, assuming 75 cents as the total cost of mining and milling, the tonnage now indicated is INDEFINITE, but certainly enormous. We BELIEVE that sound mining business will INDICATE that for the installation now proposed and for an operating period of, say, two years, IT WILL BE WISE TO CONFINE OUR WORK TO THE HIGHER GRADE ORE. There can be, in our opinion, little doubt that at some time in the comparatively near future A VERY MUCH LARGER PLANT than the one now proposed will be installed for the purpose of working a larger tonnage of the normal grade ore we now EXPECT will be developed, or of utilizing the apparently vast quantity of lower grade material.

The INDICATED earnings from the installation now contemplated are approximately $1,500,000 per annum. Considering the TREMENDOUS POSSIBILITIES, and we use the word "tremendous" advisedly, we BELIEVE this mine to be a LEGITIMATE purchase at $15,000,000 and A BARGAIN at $12,000,000, provided that, in both cases, a development, equipment and working fund of $4,500,000 is made available. You must understand and appreciate that we do not consider the 6,000-ton per day development and installation as the ultimate possibility of the mine or anywhere near it. The POSSIBLE tonnages of ore INDICATED in this property APPEAR to be greater than any vein deposit WE know about.

We EXPECT the first unit of the new mill to be in operation on or before January 1st, 1915. We really BELIEVE that, barring accidents, the time MAY be made July 1st, 1914.

(Signed, D. C. JACKLING.
July, 1912. A. F. HOLDEN.

EXPLOITING THE DEEPEST AMERICAN GOLD DEPOSITS

By AL. H. MARTIN.

For sixty years the Mother Lode has made history. From the first strike of gold quartz on the Spring Hill claim in 1851 to the present date the region has been one of the most consistent gold yielders the world has ever known. The Mother Lode embraces five counties, Amador, Calaveras, El Dorado, Tuolumne and Mariposa, comprising an area of 7,511 square miles. The lode strikes from Bridgeport, Mariposa county, northwesterly to near the further boundary of El Dorado, an approximate distance of 120 miles. The region is geographically situated in the westerly foothills of the Sierra Nevada mountains, in the north-central portion of California. The formation is composed largely of slate, sandstone and chlorite schist, with extensive areas of granite and diabase. Broad belts of diorite, diorite schist, black slate and serpentine also occur. The serpentine belt is particularly prominent in Tuolumne and Mariposa. Main ore deposits occur in a clay-slate formation, at times altering to greenstone-schist. The serpentine contains numerous veins, but these though larger than other deposits generally lack high quality. Considerable faulting and shearing appears in the slate and schist, with the parallel ore-bearing fissures numerous and varying largely in extent. Pyrites abound, while galena, blende and other sulphides are associated with most deposits. With exception of varying percentages of sulphurets, practically all the quartz is free milling. In such a vast mineralized territory the character and size of veins naturally vary. In some districts the orebodies average from ten to forty feet, while in other sections the orebodies show widths of eighty to 150 feet. Narrow shoots of high-grade ore are frequently encountered, and rich pockets have been found in most districts. On an average values range from $5 to $8 per ton, but numerous shoots containing $20 to $50 have been developed in many of the big low-grade properties. Geographically the district is old, and it is believed thousands of feet of the veins have been eroded during the centuries by the natural force of the elements. Lindgren estimates the deposits were originally formed at not less than 6,000 feet below the surface, but the erosion of the ages gradually wore down the protecting earth and carried off vast quantities of the veins.

Aside from its impressive extent, the Mother Lode is remarkable for the depth to which the deposits of commercial quartz extends, and the general free-milling character of the ore. From the earliest inception of mining on the belt the milling problem has been a simple one. Values have always been easily extracted by simple stamp crushing and amalgamation, and the more refractory ore has given up its gold to simple canvas concentrators and vanners. This naturally favorable condition led to the development of wonderfully profitable mines when the metallurgical science was in its infancy and influenced a tremendous influence on the development of western mining when refractory deposits would have checked the ardor of the most enterprising.

The depth to which commercial values prevail forms another striking feature of the lode. Particularly is this true of the Amador section of the belt, where much of the best ore has been extracted from below the 1500-foot levels. In their lower regions the mines are generally dry, and the absence of water and large dimensions of veins have facilitated the continuation of profitable operations at great depth. Some of the best producers at present were in former years considered practically valueless, and many of the most promising mines of today were reopened after long years of idleness.

ANNUAL PRODUCTION.

The annual output of the Mother Lode approximates 1,500,000 short tons, valued at about $5,555,000. Of this amount more than one-half the values and one-third the tonnage comes from Amador county. Calaveras and Tuolumne contributes most of the balance, the two counties of El Dorado and Mariposa playing minor parts. The figures of the U. S. Geological Survey credits Amador county with producing 692,806 tons of ore in 1911, yielding $2,832,395, compared with 547,875 tons in 1910, valued at $2,584,809. Calaveras yielded $1,112,315 in gold for 1911 and Tuolumne $1,093,484. The prominent part played by the Mother Lode in California gold production is evidenced by the fact that it contributes over 40 per cent of the states' quartz gold product per annum, and over one-third of the total gold yield from all sources. The lode has not played this part for a few brief years only, but virtually ever since the gold industry of California was placed on its present firm basis. Many of the mines commenced producing in the early '50s and still contribute large sums to the annual yield of the state. The average recovery from Mother Lode ores approximates $3.78 per ton. This ranges from the $2.25 ore of Calaveras to the small amount averaging over $7.40 from Mariposa properties.

DEEPEST GOLD MINES.

Paramount interest naturally centers on the Amador portion of the belt where the deepest gold mines in America are operated First and foremost stands the Kennedy, the largest producer in California. This property has been developed to a vertical depth of 3,550 feet by a three-compartment shaft, and arrangements have been recently made to sink several hundred feet deeper. In the lowest workings the vein shows about fifteen feet of milling ore and it is expected to eventually intersect the foot-wall ledge at a depth of 4,400 vertical feet. This is the principal orebody and occurs in schistose greenstone. It has been the general condition that the veins have gathered strength with increased depth, while values have been well sustained. The shoots range from six to eleven feet wide, with lengths varying from 500 to 700 feet. The quartz occurs in slate with sulphurets and considerable free gold showing. Much of the ore runs into the ribbon rock type, with coarse gold and sulphurets deposited in the dark slate seams. Values average $5 to $10 per ton, including the occasional shoots of high grade found from time to time. The Kennedy first commenced production in the early '60s, and was several times condemned as a failure before enterprising and resourceful management placed it on its present basis. The development of the property marked the first comprehensive attempt to explore the Mother Lode deposits at great depth and the results largely influenced the determination of other operators to mine deep. The Kennedy produces about 180,000 tons of ore per annum, valued at approximately $1,000,000. The quartz if crushed in Knight rock-breakers and sent to the 100-

stamp mill. Silver-plated copper amalgam plates receive the stamp product, and the pulp continues to 40 six-foot Frue vanners and a complete system of canvas tables for further treatment. Concentrates are treated by the chlorination process, the Kennedy company operating a highly efficient chlorination plant. A complete description of this mine and plant appeared in the August, 1911, issue of Mines and Methods.

After the Kennedy, the most interesting of Mother Lode properties, is probably the South Eureka, near Sutter Creek. Like the Kennedy this property was condemned in its early infancy, and again after several years of vigorous development had failed to produce anticipated results. Its history is a striking testimonial to the faith of the Western miner and the dogged determination to compel Fortune to smile despite her darkest frowns. Unlike many other noted mines, the South Eureka gave no indication of the riches concealed within its ample bosom. For nearly thirty years the site of the mine was a mere agricultural tract, yielding bountiful harvests of grain. Neither outcrops or promise of ore existed; the land was flat, unbroken and seemingly devoid of mineral promise. For years the Oneida and Central Eureka had been worked, and the fact that the tract now comprising the South Eureka mine was situated between the two properties, led to the belief that veins continued under the prosaic farm lands.

Approximately twenty years ago James F. Parks decided the land invited investigation and forming a company of friends started explorations. Parks had transformed the Kennedy from an abandoned failure into one of the world's great mines, and hopes of the adventurers soared high. The early developments were encouraging and work was pressed vigorously. But soon the exhaustion of funds caused the levying of assessments and the stockholders commenced to loose courage. Almost from the outset the South Eureka seemed to take a fiendish delight in raising high hopes only to hurl them to the blackest depths. Again and again strikes were made that warranted further work, and it was finally decided to erect a mill and modern mine equipment. A few months of prosperity developed, but again values fell off and again the call went out for assessments.

For eighteen years this condition continued until even the boldest lost heart and a noted engineer was consulted. After a complete examination of the property a discouraging report was issued. For a few months the fate of the mine hung in the balance. Then the leading spirits, against their better judgment, determined to continue. Many of those who had paid assessments for so many weary years, however, flatly refused to have anything more to do with a proposition that swallowed gold instead of yielding it. In numerous instances stock was given to those who would pay assessments.

TURN OF THE TIDE.

And then came the turn of the tide. About three years ago Henry Malloch, secretary of the company, became its president. Always cherishing faith in the property he determined on a final effort to compel success. From the 2,500-foot level it was decided to drive a westerly drift and explore a portion of the virgin holdings. A three-foot vein of $4 ore had been developed here, but of itself commanded scant attention. For eighty feet the drift was extended—and a big vein struck. With every recourse at its command the management feverishly pressed developments, for it was generally realized that the life of the South Eureka depended on the result. The culmination of the work demonstrated a ledge fifty feet wide carrying average gold values of $6.50 per ton. The stockholders heard and gathered courage, and a steady demand commenced to develop for the so recently despised stock. Another drift was sent out from the 2600-foot station and again the vein was encountered with its earlier characteristics prevailing. Cross-cuts were rushed from other levels and the result satisfied the owners that success had been granted them after the long and hopeless years. The stock immediately shot upwards and men found themselves on the road to wealth when all hope had been abandoned.

Within a few months the vein had been proven from surface to the 2,600-foot workings and a second orebody, rivaling the first in size and character tapped. It was evident the South Eureka was destined to become one of the great mines of the state. New equipment was provided, the working force increased, and dividends took the place of assessments. Not only did the owners of the South Eureka benefit, but the discoveries sent a wave of encouragement all over the lode and capitalists began to favorably consider mines that had lain idle for long years. The South Eureka company itself became interested in outside properties and acquired the Oneida, one of the famous old producers that had lain neglected for years after establishing a splendid record. The development of the Oneida is being carried forward vigorously and the excellent ore recently developed indicates the property will again become an important producer.

MAIN LEDGES IN SLATE.

The main ledges of the South Eureka occur in slate, with bands of soft gouge dividing the quartz from walls. The veins are gradually converging toward each other and are calculated to meet near the 3,000-foot point. In addition to the main deposits, several small shoots have been developed, with values at times running high. Values vary widely, but the average is near the $6.50 mark. The three-compartment shaft has an incline depth of 2,800 feet and is equipped with a Knight & Co. electric hoist having a capacity of four tons from a 3,000-foot depth. The four-ton skips travel at the rate of 1,250 feet per minute. A 400-H. P. Westinghouse motor supplies the energy. To take care of the small flow of water a pumping system, including reservoirs on the 2,000 and 2,700 levels, has been provided with a capacity of 200 gallons per minute. Machine drills are used in development and blocking out ore. Quartz is seperated from waste in the stopes and delivered to the cars supplying the mine skips. At the shaft collar the ore is received by a 200-ton capacity bin, with the waste placed in a receptacle containing 50 tons. The bin feeds through six improved chute gates into cars which tram the product to the mill building. The mill bin, containing 2,800 tons, feeds to eighty 950-pound stamps having a capacity of 400 tons per twenty-four hours. The plant is of the back-knee, A-frame battery type, and outside amalgamation is employed. From the plates the pulp passes to forty six-foot Frue vanners. In the past this completed the treatment for gold recovery but the management purposes to install a canvas concentrating plant to effect extraction from tailings leaving the vanners. Such concentrators are very extensively employed in Mother Lode practice and give excellent satisfaction. Mining and milling costs aproximately $2.63 per ton. The mill is operated throughout by electricity. Four Westinghouse 50 H. P. motors drive the stamps.

ANOTHER DEEP ONE.

The deepest mine on the lode, after the Kennedy, is the Argonaut. Like the Kennedy this property is located in the Jackson district and has secured greatest profits at great depth. The main shaft has an incline depth of 3,800 feet and is being deepened to the 3,950-foot point. This corresponds to an approximate vertical depth of 3,400 feet. The orebodies occur in a slate formation, with the veins stronger and less broken than is usual in many neighboring properties. In size the ledges range from twenty to thirty feet with values averaging around $5 per ton. The Argonaut is one of the oldest of Mother Lode mines, and like many other mines of this region the surface deposits were practically valueless. At the 600-foot point the first commercial

ore was found, but the prosperity of the mine dates from the rich strikes made on the 1,600 level. The mill comprises forty stamps and usual vanner annex, the plant having a capacity of 200 tons per day.

One of the more famous old producers that is being reopened is the Keystone, near Amador City. The Spring Hill claim of the group, at one time designated the "Minister's Claim," was the scene of the first quartz discovery in the Amador field, the strike being made in 1851, two years after the great California gold rush developed. From the first good grade ore was found, but swelling ground proved an unexpected source of great expense, and only by herculean efforts were the owners able to keep the property in action.

On one occasion the owning company purchased considerable hay from a Campo Seco rancher. Time passed and the hay had not been paid for. The indignant rancher proceeded to play a card on his own account. He employed the sheriff to watch the mill and to seize the amalgam when clean-up day arrived. The superintendent learned the officer was in his vicinity and suspecting a coup, calmly took the amalgam down into the mine and concealed it. Men of those days were not prone to hesitate. Action was the keynote of existance. For the weakling there was no place among the sturdy Argonauts. So the sheriff learning of the bold plot of the mine manager serenely entered the property and commenced a search for the amalgam. The superintendent, nothing daunted, promptly stopped the pump, planning to flood the lower workings and save the gold. But the wary officer soon appeared at the shaft mouth—and he had the amalgam. Such were the means often prevailing among owners to keep their properties operating at any cost.

In 1866 was made the strike that for years placed the Keystone among the great gold yielders of the world. East of the hangingwall vein an easterly crosscut was driven and a new ledge, literally spangled with gold, intersected. For year after year the property continued a sensational production, and it is officially recorded that 1$7,000,000 was recovered from above the 1,000-foot point. The exhaustion of the rich ore, and increasing costs attending further depth, led to the subsequent closing of the Keystone. A year ago new interests acquired the famous old property and commenced sinking the shaft to 2,400-foot point. The work has advanced past the 1,800 level, and indications are considered bright for the restoral of the old producer to a high place among the big mines of the state.

THE PLYMOUTH AND OTHERS

The Plymouth Consolidated, in the Plymouth district, is another old property recently reopened. This group is officially credited with an output of about $6,500,000. The orebody, when last worked, ranged from forty to seventy feet wide, with the principal shoot thirty to fifty feet wide. This consisted of ribbon quartz. The average yield from ore ranged from $6.18 to $7.50 per ton through several years. The main shaft, the Pacific, was sent to a depth of 1,700 vertical feet. The California Exploration Co., an English syndicate, is now engaged in reopening the old property and plans to send the shaft deeper and thoroughly prospect the lower workings.

Other large Amador producers are the Bunker Hill, Central Eureka, Fremont, Zelia and several others. As in other prominent portions of the lode, mining must necessarily be conducted on a large scale to achieve profitable results. The low grade of the ore, and the immense veins, forces the maintenance of large mills and employment of large crews of men, consequently the average Mother Lode mine is not a proposition for the small operator. But the vast extent of the veins, the excellent climate and favorable ore characteristics appeals attractivey to the man of large resources.

In the Calaveras portion of the lode, the principal mines are located in the Angels camp district. Here the Utica company has developed large bodies of milling ore below the 1,500 points in its Cross, Gold Cliff and other mines, while the Angels and other companies have aso demonstrated commercial deposits at considerable depth. Most of these properties are equipped with mills embracing forty to eighty stamps. In the Melones district the Melones Mining Co. operates on a massive deposit of low-grade ore to a depth of 1,100 feet from the surface. This deposit is a veritable mountain of ore and has been developed principally by adit workings. The glory hole method is employed, and beneath this main orebody veins of commercial quartz have been demonstrated. The company operates a 100-stamp mill.

TUOLUMNE COUNTY MINES.

Tuolumne county boasts several fairly deep properties, but the mines hardly approach the magnitude of the large Calaveras producers, or the still more colossal Amador yielders. The Eagle-Shawmut, the largest producer, has been developed to an incline depth of 2,700 feet and is equipped with a 100-stamp plant. The App, Harvard, Soulsby, Black Oak and a host of other famous old producers still contribute to the golden yield of the county. Practically all of these are mining, or have developed, ore of profitable grade below the 1,000-foot point. In the past several years El Dorado and Mariposa county mines have established splendid records, but the cost of mining attending increasing depth, and generally limited finances of owners have militated against heavy production in the past decade.

While the glory has departed from many of the old districts, many eminent engineers predict the old mines will again command high regard when companies of ample financial strength become interested and work is conducted along modern lines. The Princeton, most famous of Mariposa producers, has yielded in excess of $5,500,000 and has been developed to an incline depth of 1,600 feet, corresponding with 1,250 vertical feet. The vein has been proven for a continual length of 1,500 feet and at the bottom of the shaft is six to eight feet wide.

All the deep mines, as depth is reckoned on the lode, are located in Amador, but there appears many good reasons why the future should record the development of properties in other counties that will compare favorably with the deep producers of Amador.

It naturally commands capital and courage to sink deep shafts through broad areas of comparatively unproductive territory with only a possibility that at depth deposits of sufficient value and magnitude will be found to reward the enterprise and initiative of operators. And only strongly financed companies are justified to pursue such steps. But the free-milling ore, congenial climate and plentitude of water and timber in most sections, are mighty factors in the future deep development of the lode in districts where operators have hitherto been fairly content with the output from comparatively shallow workings.

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The extreme solubility of nitrate salts renders it unlikely that concentrated deposits will remain anywhere except in places either not subject to or protected from the solvent action of rain, surface water, or moving ground water. Thus nitrate salts are found chiefly in caverns or caves, or under overhanging ledges, or, as in the Chilean and other South American occurrences, in a region of exceptional aridity. The assertion that none of the nitrate deposits of the character mentioned will prove commercially workable is not warranted. Such deposits have proved to be of value under exceptional conditions, as when they were utilized for the manufacture of gunpowder, during war times in the Eastern states; and it is entirely possible that changing conditions may render some of the Western deposits valuable. It must be recognized, however that, so far as may be judged from present evidence, few if any of the deposits now known warrant much outlay for development as a source of commercial nitrate salts.

HISTORY AND GEOLOGY OF ANCIENT GOLD FIELDS

By LEON DOMINIAN.*

The lack of Aryan roots for the names of metals commonly known among the Aryan settlers of Asia Minor, as well as the later colonizers of Europe, indicate that these races were generally ignorant of the use of metals until they came into contact with Semitic peoples. Practically all mining-terms in current use among the earliest Greeks resemble very strongly their distinctly Semitic equivalents, which can be traced all the way in a broad belt beginning in Lower Mesopotamia, and extending westwardly to the Syrian shores of the Mediterranean. The Greek word "metallon," for instance, used indiscriminately to designate mine or ore, probably came from the earlier Semetic equivalent, "matal." Again, the Greek word "chrysos" (gold) and "chalkos" (copper) seem to be descended from the Semitic forms "chrouts" and "chalak." It is a natural inference that primitive mining methods were evolved by the dwellers in the mineralized areas of Asia Minor, from whom later Greek, Roman, and even North European miners obtained their first notions of the reduction of metallic ores, by virtue of a general westward migration of mining and metallurgy. Some traces of its passage through Turkish territory will be noted in this paper.

While European Turkey can boast of one ancient gold-field, the Asiatic dominions of the Sultan may lay claim to at least two well-defined and widely separated gold-producing districts. These three regions may be distinguished as the Thracian, the Pontic, and the Anatolian gold fields.

THE THRACIAN GOLD-FIELD

The most conspicuous topographic feature of the lowland between Constantinople and Salonica is the uplifted Archaean mass known as the Rhodope mountains. This chain appears to be a southern prolongation of the boundary-defining Kara Balkan range, from which it extends with an approximately north-south trend until it almost dips into Aegean waters at the Gulf of Lagos. It forms the backbone of the Thracian metalliferous province, and is intimately related to gold-mining in the region. Starting from within its folds, that industry found a propitious field eastward up to the site of the placers of the Hebrus river (the modern Maritza), mentioned by Pliny.[1] On the west, gold was won as far as the banks of the Strymon[2] (the modern Struma or Karasu). These two water-courses give fairly accurate east and west boundaries of this important district on the mainland. The island of Thasos, lying west of the Rhodope mountains, to which it is petrologically related, also belongs to this same metalliferous province. Fig 1 is a sketch-map of Turkey in Europe, showing the Thracian gold-field.

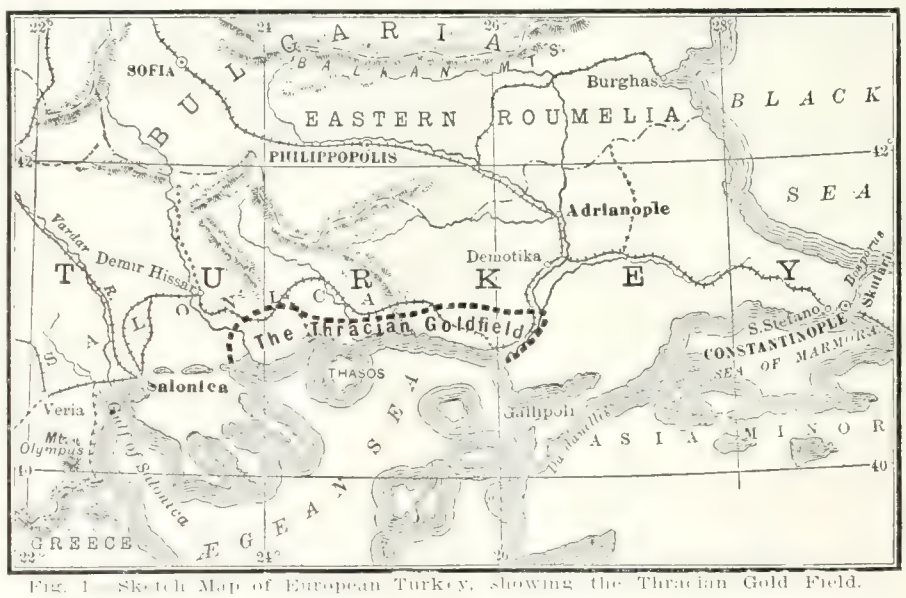

Fig. 1.—Sketch Map of European Turkey, showing the Thracian Gold Field.

The Thracian coast consists of highly-metamorphosed pre-Eocene formations[3] that appear to have been much dislocated, so that the general appearance is that of an archipelago of old rocks in the Eocene sea. The component rocks include mica and hornblende-schists, crystalline limestones and marbles, gneisses and granite, and serpentines, upon all or which Tertiary deposits rest unconformably.

The Phoenicians seem to have been the first to conduct organized mining operations in this region. Yet there is no reason to doubt that the aboriginal Thracian tribes were acquainted with the values of the metals found in their subsoil, and it is likely that they led enterprising prospectors from the south more than once to the site of the mineral deposits, as Indians have shown quartz and other veins to the white man in the far west. According to Greek mythological tales, mining was first undertaken on Mount Pangeum by Cadmus,[4] who settled in Thrace while engaged in his search for Europa, who had been carried off by Jupiter. Lenormant[5] claims that Cadmus in this story represents Phoenician settlers who immigrated into Thrace. The date of this beginning of what was destined to become a flourishing industry is set at 1594 B. C. by Abbe Barthelemy in "Adacharsis."[6] Other historians place it at as much as a hundred years later; but whatever be the true date, there is no doubt of the colonization of the district by Phoenician immigrants, of whom a constant procession from the southeastern shores of the Mediterranean was persistently wending its way northward.

The exact location of Mount Pangeum has not been established; but it is known to be in the range running parallel to the coast between the valley of Anghista or eastern portion of the valley of Serres and the high road from Orfano and Pra-

* Mining Engineer, New York. Trans. Am. Inst. of Min. Engineers, Nov., 1911.

1 Book xxxiii., chap. 21.
2 J. Malcolm Maclaren, Gold, p. 160 (London, 1908).
3 Quarterly Journal of the Geological Society, vol. lx., No. 239, p. 243 (Aug., 1904).
4 Diodorus Siculus, Book v., chap. iv.
5 Premieres Civilizations, vol. ii., p. 321.
6 W. Jacob, An Historical Inquiry into the Production and Consumption of Precious Metals, p. 41, footnote.

vista.[7] It has been called Punar Dagh on some maps, and the old mine-workings are supposed to have been found on the Pilaf Tepe peak. The production of gold from this locality was large enough to give rise to various legends of the riches locked up within the bosom of these mountains. At the height of the power of the kings of Macedonia, shortly after 400 B. C., it was the prevailing popular belief in this part of Thrace that gold extracted by the pick would immediately grow again like grass mowed by the scythe.

It is not surprising that the possession of such gold-bearing lands was ardently coveted by rival Greek states. To mention but a single case, in 465 B. C., the Thracians revolted from the maritime confederacy headed by Athens, on account of a quarrel concerning the Thracian gold mines, with the Athenian settlers at Eion, on the Strymon.[8] At that time the Thracians were actively working their own mines, although, according to Herodotus,[9] these were beginning to show signs of exhaustion. It is therefore highly probable that they were spurred on to investigate the possibilities of the adjoining mainland, and that in this pursuit, their interests clashed with those of others similarly occupied. At all events, the Thracians figure as the principal owners of the mines around Datum, a very important mining town near the coast, and once an opulent city, thanks to the wealth which its inhabitants derived from the ownership of the gold-mines.

Another known locality of similar industrial activity lies north of Datum. It was called Crenidae at first, and Philippi subsequently. The last name survives to this day, marking the site of ruins which the traveler cannot fail to notice, almost halfway between the town of Drama and the sea-coast. Thracian and Athenian miners had settled in this vicinity in the fifth century B.C., and for a while were very actively engaged in their craft. In 357 B.C., however, the only traces of foreign enterprise still discernible consisted of scattered abandoned workings. The mines had reverted to the Thracians, who had become effete through the distribution of wealth accumulated by their predecessors. Some time in that year, Philip, king of Macedonia, marching victoriously eastward, reached Amphipolis, 30 miles west of Crenidae. His attention was directed to the mines, reports of the richness of which must have been still current. Probably in need of funds for the execution of his vast projects, the conquering sovereign did not disdain to investigate the old workings for himself. He descended underground,[10] and supervised in person by dim torch-light the cleaning out and unwatering of the "canals" (drifts). Canal is the term used by the Scotch historian, probably to conform to the Latin texts available to him. Pliny, throughout his Natural History, uses the same term to represent underground workings. Thanks to the royal initiative, the mines were soon after placed on a producing basis and the "bosom of the earth was again opened and ransacked with avidity"—according to the Scotch Historian Royal, who relies for the substance of his account on the text of Seneca.[11] It was in commemoration of this industrial revival that the town was henceforth called Philippi. The bulk of the gold extracted was coined on the spot, to the amount of nearly 1,000 talents (about $1,000,000), annually,[12] into the now exceedingly scarce Macedonian gold-pieces known to numismatists as "Philippic." This was in those days an enormous sum, having a purchasing power far greater then than now. It bears witness to the great enterprise and activity of the Mecedonians, and may also be considered as a proof of the relatively large area that must have been included in the workings, since, with the methods of extraction then in vogue, vertical depths exceeding 300 ft. must have been attained with considerable difficulty, if at all.

It is impossible to determine the length of the period of active mining operations, after this Macedonian revival of the industry. But it seems very unlikely that Alexander should not have followed in his father's footsteps, in fostering the industrial expansion of his empire; and we may safely assume that the mining camp of Philippi continued to flourish for about a couple of decades, at least, during the hey-day of Macedonian supremacy. Two centuries later, after the battle of Pydus, and the defeat of Perses (about 168 B.C.), the region passed into Roman hands, and contributed its share to the periodical replenishment of the Roman treasury.[13]

In Byzantine times, these gold-mines, lying at the very door of the capital, could hardly have been overlooked by the wideawake engineers of the Eastern Empire, whose knowledge and skill were unsurpassed in their age. When, in the third century A.D., Rome's universal but waning power, vested in Constantinople, made that the first city of the world, the gold-mines of Thrace were still furnishing large supplies of gold. Indeed, from that time to a period in the twelfth century, when Europe was deep in the gloom of the Dark Ages, it was the part of civilized Byzantium to provide a large part of the gold currency of the world, through a continuous supply of Byzantine gold coins, which found their way to the northernmost regions of the continent.[14]

Four centuries later, and about 3,000 years after this celebrated gold-field was first exploited, it happened to be visited by Dr. Belon of Paris, a physician of Francis I. This was at the zenith of the power of the Ottoman Empire, when French statesmen were hobnobbing with their Turkish colleagues under Sultan Suleyman the Magnificent. The doctor, who was an expert in mineralogy, examined the Thracian district in 1546 and 1549,[15] and says of it:[16]

> "These mines yield so much gold and silver that the Emperor of Turkey draws from them 1,800 ducats a month, and in some months this sum attains 3,000 ducats. Within the last fifteen years the production has declined, and the duties to the Emperor have not exceeded 1,400 ducates. The persons who carried on the operations had formerly enriched themselves more than they were thought to do at present."

From his reports it appears that the mines were located on the side of a mountain in the vicinity of the village of Siderokapso, where he found conditions similar to those which he had observed at Joachimsthal in Bohemia. The presence of a large number of miners and the consequent opportunity for trade of many kinds, had drawn a motley gathering from all lands. His enumeration of the various nationalities assembled in that mining camp vividly reminds us of the various races encountered today in any camp "out west." For their methods of mining, however, the natives had drawn on the Germans, in whose language the technical terms of operations, as well as the names of tools, were currently expressed.

THE ISLAND OF THASOS.

Facing this highly-productive area on the mainland, the pile of primary rocks constituting the island of Thasos emerges out of the Aegean sea. The significant appellation of Chrysay (the Golden), bestowed upon it by the ancient Greeks,[17] shows that the fortuitous intervention of watery expanse in no wise impared the felicitous similarity of its physical features to those prevailing on the opposite shore.

According to De Launay,[18] who has thoroughly investigated the geology of the Aegean archipelago, the island consists in the main of an extensive NW-SE, anti-

7 Rawlinson's Herodotus, vol. iii., p. 219, footnote (London, 1880).
8 Phillip Smith, Ancient History, vol. i., p. 157 (London, 1893).
9 E. Lenormant, Premieres Civilisations, vol. ii., p. 331.
10 Gillies, Ancient History of Greece, vol. iv., p. 33.
11 Gillies, loc. cit.
12 Diodorus Siculus, Book xvi., chap. 8.
13 Jacob, loc. cit., p. 76.
14 Finlay History of Greece, vol. i., pp. 78, 167 (Oxford, 1877).
15 Jacob, loc. cit., p. 132.
16 M. Gobet, Les anciens mineralogistes du Royaume de France, vol. i., p. 53.
17 Arrian, Fragmenta, 67.
18 Annales des Mines, Ninth Series, vol.

cline of metamorphic beds stretching from the hamlet of Kasavithi on its western coast to the islet of Kynira on the east. These masses of primary rocks make up exclusively a complex of metamorphic schists, including gneisses, micaschists, and amphibolites, with intercalated strata of crystalline limestones and marbles. Such rocks are characteristic of the Aegean region both on the European and the Asiatic shores. The metamorphosed strata strike almost due E. and W., and are very frequently horizontal. Here and there, occasional layers of recent conglomerates cap the older rocks.

By reason of the variety of minerals occurring on this island, the Thracians were famous as miners throughout antiquity. These natural resources also acted as a powerful incentive to the colonization of Thasos, as early as at least fifteen centuries before the Christian era, by the fortune-seeking Phoenicians.[19] Towards the beginning of the 5th century B.C., Herodotus's travels had taken him to the island, where he found that mining was the chief industry of the natives. Indeed, the enterprising islanders had, by this time, extended their operations to the equally rich adjoining regions on the mainland, as described above. Their annual revenue from mining amounted to 200 talents (about $240,000) in lean years, and 300 talents (about $360,000) in years of prosperity.[20] About one-fiftieth of these totals was yielded by their holdings in Thrace proper. Concerning the mines in the island, the Father of History says:[21]

"I myself have seen the mines in question, by far the most curious are those which the Phoenicians discovered at the time when they went with Thasos and colonized the island, which afterwards took its name from his. These Phoenician workings are in Thasos itself, between Cacheari and a place called Aenyra over against Samothrace; a huge mountain has been turned upside down in the search of ores."

This remarkable description seems to leave no doubt as to the exact location of these mines.[22] Yet it was impossible for De Launay [23] to detect any traces of ancient workings at the alleged site. On the other hand, he discovered ample evidence of considerable ancient labor near the hamlet of Kakiracki, built on the diametrically opposite shore. At this point, old slags had been dumped into the neighboring gulches, often filling them entirely, particularly where they lead to Sotiro. The unusually large volume of these old dumps indicated the proximity of extensive workings and their prolonged exploitation.

The inference from these two sets of observations is that two distinct periods of mining activity must have prevailed at different places in Thasos, and that all the superficial manifestations of the earlier, which obviously must be the one referred to by Herodotus, in the passage quoted above, became completely obliterated in the course of time. It should also be noted that both sites correspond to homologous points on the anticline, and that mineralization of the one would, all things being otherwise equal, warrant the assumption of a similar phenomenon at the location of the other. These facts, coupled with our knowledge of events in Thrace, enable us to reconstruct the story as follows:

At some time before the 15th century B.C., Phoenician explorers, sailing from the southeast, landed in Thasos at a point near Kynira, where the outcrops of the pyritic bodies (seen by De Launay) attracted their attention. That such outcrops might be auriferous is entirely in harmony with our present knowledge of this class of deposits; and the gold-bearing zone need not necessarily be confined to the mere outcrops but might comprise all the oxidized upper levels of the ore body. The recovery of the metal would be effected mainly by means of washing and panning, although amalgamation also might have been employed occasionally, since it is now known that the properties of mercury in this connection had not escaped the attention of the ancient gold-seekers.[24] After the working of the upper levels at Kynira, and probably before any attempt had been made to invade the mainland, the surface of the island was minutely explored, and the deposit lying on its western coast was discovered and likewise made to yield its precious contents. The slags observed by De Launay indicate the use, in this district, of other metallurgical processes.

Another site of ancient exploitation is known to have existed north of Thasos, in the small island of Thassopoulos, known in the days of Herodotus as Scapte-Hyla. The annual revenue of its mines in 492 B.C. amounted to 80 talents[25] (about $100,000). One of the eminent owners of mines in this locality was the wife of Thucydides,[26] whose wealth may have enabled him to devote himself to study and literary labor.

Such is the partial record of a region, characterized by the resumption of profitable mining-operations at various intervals during nearly forty centuries. Undoubtedly much might be added by more learned and leisurely compilers to this imperfect, yet, I trust, suggestive outline. Researches into the industrial activity of former generations are not always totally devoid of economic value to the modern engineer. While many of the principles actuating ancient technical practice have now become obsolete, it may be questioned whether the faculty of reasoning upon available data and of dealing with immediate conditions has been notably increased; and the ancients, judged according to their light and their tools, may still be worthy of our study and our respect.

No work of importance has been attempted on the mainland section of this gold-field within recent years. It is interesting to note, however, that the island of Thasos has now become a zinc-producer. The annual production of calamine from mines owned by the Metallgesellschaft of Frankfort amounts to 30,000 metric tons.[27] Whether a similar change in the metal-production of the mainland deposits will hold true, remains to be determined by future observers; but it is quite possible, in accordance with anologies, that the future gold-production of these ore-bodies may not be again as abundant as it has been in the past.

ASIATIC TURKEY.

Three major folded arcs, forming as many independent chains of lofty peaks, fringe the wave-battered shores of Asia Minor, and, encircling, rim-like, its elevated barren plateaus, determine the trend-lines[28] of the structure of this western-most projection of the Asiatic continent. Within the mighty folds of each occurs an auriferous zone, gentically related to copious lava-flows of comparatively recent origin, detailed studies of which are yet to be made.

The Pontic gold-field lies in the most easterly, and the Anatolian gold-field in the most westerly, of these zones of disturbance, the effects of which have been so far-reaching upon the development and history of the peninsula. A third gold-field, of altogether minor historical importance, lies on the slopes of the Tauric mountains, the most imposing of these three great uplifts. Fig. 2 is a sketch-map of Asiatic Turkey, showing the gold-fields.

This occurrence, within the only zones where heavy mountain-making agencies have been at work, of the only known gold-producing areas in Asia Minor, can scarcely be regarded as a mere coincidence, though it would be hazardous, at this incipient stage of our knowledge of the geology of the region, to carry our generalizations too far.

A glance at the early history of this tramping-ground of our Aryan forefathers

xi., p. 237 (1883).
19 Cf. Rawlinson: Phoenicia, p. 60 (New York, 1889).
20 Herodotus, Book vi., chap. 46.
21 Ibid., chap. 47.
22 This locality is probably the one called at present Kynira; it is an islet lying east of Thasos and facing Samothrace.
23 Loc. cit.
24 Pliny, Book xxxiii., ch. p. 78.
25 Herodotus, Book vi., ch. p. 46.
26 Marcellin: Vita Thucydidis, p. 9.
27 Private correspondence of the writer.
28 Neumayr, Heinrich's Geographische Zeitschrift, Vol. ii., pp. 7 to 27 (1896).

gives the impression that the region was both better known and better appreciated by them than by its modern inhabitants. Fully 3,000 years ago, Asia Minor, as a human habitation, was already very old, and there flourished in certain portions of it a civilization as advanced in many of its phases, as the later Roman culture ever was.

Along with the recognition of the economic value of various ores, mining had assumed such importance as to have become the means of sustenance of numerous settlements scattered from the Aegean coastland to the Persian gulf. Within that territory, empire after empire had risen to power, and passed into oblivion. Colonies of the vanished kingdoms of Summer and Akad, preceding the Babylonian empire itself, had flourished in the fifth millenium B.C. With the westward march of progress, the Hittite power came into being; and finally, the ten centuries immediately preceding the birth of Christ witnessed an unparalleled growth of civilization on the eastern shore of the Aegean sea. During this period Greek paganism evolved a highly-advanced organized life. In each of these successive stages of culture, the art of working ores was profitably carried on; the metals being respectively valued according to their relative abundance and usefulness, or commercial importance.

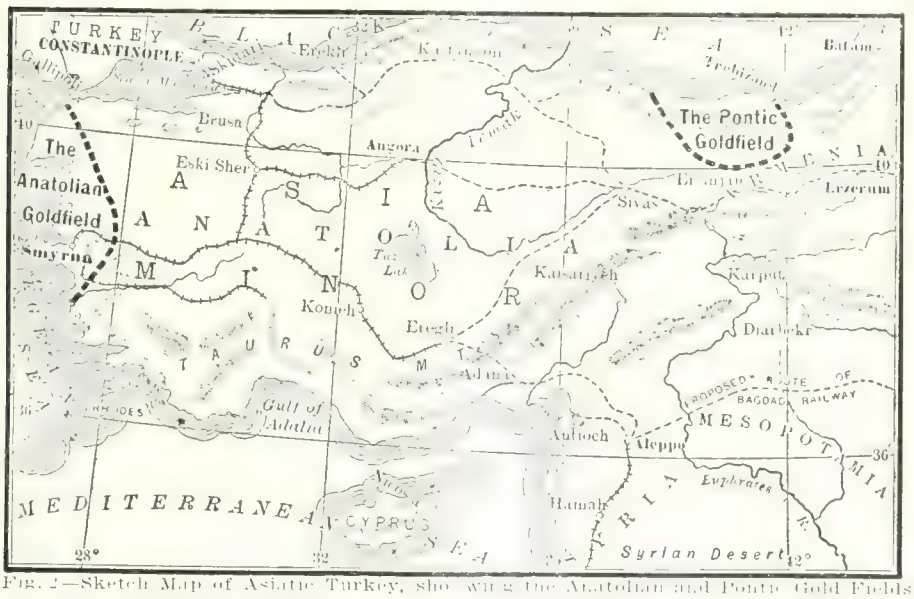

Fig. 2—Sketch Map of Asiatic Turkey, showing the Anatolian and Pontic Gold Fields

THE ANATOLIAN GOLD-FIELD.

This metalliferous province forms part of a geologic belt extending from the plains of Troy to the valley of the Pactolus, and slightly farther south, so as to include Mount Tmolus—the modern Boz Dagh. It contributed largely to the gold output of proto-historic times, and, as might be naturally expected, it has been duly commemorated in various legends which have descended to us, together with the superabundant exaggerations with which ancient exploits were wont to be embellished.

Its northeast portion was explored during antiquity in the vicinity of the Asiatic shores of the Dardanelles. The abundance of gold jewelry found in the excavations on the site of the several cities of Troy indicates a large production of gold from localities probably not far away. The best-known of these mining camps of the Troad flourished between Pergamos and Ataineos, and were inhabited by the Dactyles, a hardy and enterprising race. Strabo, in the course of his travels, found numerous traces of ancient workings[29] in the vicinity of the ancient town of Astyra, then a ruined city which formed part of Abydos, but which had been independent when the gold mines in its vicinity were productive. At the time of Strabo's visit, close to the dawn of the Christian era, the mines had been practically abandoned, and the formerly prosperous mining camp had dwindled to commercial insignificance. The extent of the ancient workings seen by him indicates that mining had been carried on very actively at this point, and legendary tales often attribute the immense wealth of Tantalus or of Priam to the ownership of these diggings.

The site of Astyra is supposed to coincide with that of the modern hamlet of Serjiller, about 14 miles south of the Dardanelles. Abandoned workings of considerable extent are known to exist at this point, in a mica-schist country, intruded upon by lower Tertiary igneous rocks, which according to Diller,[30] English and Flett,[31] consist of liparite, mica-hornblende, and augite-andesites, the latter in an advanced stage of decomposition. All these volcanic rocks have been ultimately capped with basalt. This igneous series is remarkably similar to some which have been observed in various zones of volcanic activity within the American Great Basin region, such as the southwestern portion of Nevada, where appreciable amounts of gold have been yielded by veins incased within rocks, the chief characteristic of which appears to consist in the intermediate composition, in a scale of decreasing acidity of the magmas from which they have solidified.

A portion of the large quantity of gold articles unearthed on the site of Troy must have been derived from Phrygia and Lydia, two of the most important mining provinces of the world in the first millenium B. C. It may be recalled here that the Troad borders on Phrygia, where, according to ancient traditions, the discovery of the art of fusing metals took place in the course of a forest fire, during which is was found that fragments of ore had been accidentally melted.[32]

There cannot be any doubt that the Phrygians, in common with their better-known eastern neighbors, the Lydians, were the most renowned miners and metallurgists during the pre-eminence of Hellenic culture. The profusion of mineral species, enumerated by Pliny as found in these kingdoms, indicates that the natives had abundant opportunities to become proficient in the arts of mining and smelting. Lydia especially was renowned for its wealthy rulers and citizens, most of whom were owners and operators of mines. Sardes, the capital, was long a world-market for gold, silver, copper, and iron. Not only did the Lydians derive large incomes directly from their underground operations, but, being situated, geographically, midway between Western culture and Eastern splendor, they managed to act as commission agents for both parties, so that products from either direction paid them toll in transit, and thus increased the wealth of the Lydian capitalists. Herodotus mentions[33] the colossal fortune, reaching far into the tens of millions of dollars, amassed by Prince Pythios, supposed by some to have been a descendant of Croesus, the wealthiest of the kings of Lydia. This nobleman was the dynast of Celenes when Xerxes invaded the West. Plutarch declares[34] that it was his custom to prevent the inhabitants of the mining districts under his rule from pursuing their agricultural labors, lest the time thus spent be subtracted from more profitable employment at underground work. We can

29 Book xiii., chap. 1.
30 Quarterly Journal of the Geological Society, vol. xxxix., No. 156, p. 627 (Nov., 1883.)
31 Idem, vol. lx., No. 239, et seq. (Aug., 1904).
32 Lucretius, lines 1240 to 1243.
33 Book vii., chap. 27 to 29.
34 Moralite, vol. i., p. 324.

more easily understand such conditions when we take into consideration the great scarcity of metals, and the consequent demand for them, which existed at that time throughout Europe. The lack of gold was particularly felt in Greece in the sixth century B. C., when the Lacedemonians had to import expressly from Lydia the relatively small amount required for the gilding of a statue.[35] With regard to the wealth of Croesus, Rawlinson, referring to Strabo, says[36] that its reality cannot be questioned; for Herodotus had himself seen the ingots of solid gold, six palms long, three broad and one deep, which to the number of 117 were laid up in the treasury at Delphi.

The height of Lydian prosperity was attained in the first quarter of the seventh century B. C., and successfully maintained during the ensuing 250 years. Throughout this period the precious metal was won both from alluvial and from deeper mining. Glowing tales concerning the gold-producing banks of the Hermos were spread to the confines of the world; and many are the legends that spring from the accounts of the rich clean-ups made by enterprising Lydian prospectors in washing the gravels of the Hermos and its tributary, the Pactolus. The latter stream owed its gold, according to an ancient story, to the fact that Midas, the mythical founder of the Phrygian kingdom, had bathed in its waters, upon the advice of Bacchus, in order to be deprived of the fatal faculty of turning everything he touched into gold. This tradition, like so many others of a kindred nature, has value only as indicating the existence of an ancient and flourishing placer industry in the valley of the Pactolus. This river, as well as the Hermos, of which it is an affluent, rises on the northern slope of the Tmolus mountain, itself the site of numerous mining excavations. It may be safely assumed, as an explanation of these old workings, that the discovery of nuggets in the river sediments stimulated a careful examination of the immediate vicinity, and that this search led the ancient prospectors to the ultimate source of the gold, namely, to the auriferous veins of the mountain.

How prolific in their yield of the precious metals these banks of the Pactolus must have been may be inferred from a partial review of the frequent allusions in ancient literature to the gold-bearing sands of this famous river. Tchihatchaff's enumeration[37] suggests the strong appeal made by this source of wealth to the imagination of ancient writers. Among others, Scylan of Caryadnis[38] speaks of the Pactolus as having formerly borne the name of Chrysoroas (the gold-bearing), by reason of its auriferous character. He claims, furthermore, that the precious element was engendered eternally in its waters. Herodotus also alludes[39] to the gold carried by this stream; and it is interesting to note that he lay special stress on the notion that the gold was primarily obtained from the flanks of Mount Tmolus. Poets and writers in endless succession have extolled the good fortune of the Lydian prospector. Virgil,[40] Juvenal,[41] Sivius Italicus,[42] all refer in glowing terms to the gold-laden muds borne along with the flowing waters. Seneca,[43] with wonted emphasis, describes the river as inundating the fields with gold (inundat auro rura).

Nevertheless, this production was not destined to be everlasting. In Strabo's time, at the beginning of the Christian era, it had dwindled to comparative insignificance. Philostrates[44] quotes Apollonius as saying that the Pactolus was "formerly" auriferous; and, inasmuch as this celebrated philosopher was a contemporary of Nero and of Vespasian, it may be inferred that very little gold was recovered from this source at that time. The same writer advances the hypothesis of the primary derivation of the nuggets from the very rocks of Mount Tmolous, and his assertions in this respect indicate a remarkable soundness of deductive reasoning. In the light of modern theories on placer-formation, a part of their metallic contents may well have been derived from the rocks incasing the veins which, in the course of their erosion, have contributed the bulk of the metal subsequently re-deposited in the form of nuggets.

A later writer, Festus Avenius,[45] makes use of the term "auriger" in the text of a description of this affluent of the Hermos. His use of this adjective need not, however, be taken as indicative of a renewed activity of mining on the Pactolus. It may have been employed by way of reminiscence only. Such, indeed, appears to be the case in the writings of Constantine Manasses,[46] a Byzantine writer of the eleventh century; and John the Lydian,[47] a native of the valley of the Hermos, alludes to the Pactolus merely to refer to its past contributions to the world's wealth. In our own time, peasants dwelling in the vicinity of the Box Dagh are known to make a scanty livelihood by washing the gravels brought down by the rivers. But their appearance and mode of living are far from supporting a belief in the continued abundance of the yellow metal in that region. It is therefore possible that the placers of this gold field were exhausted fifteen centuries ago, although the same assertion might not be made with regard to the original sources of the nuggets discovered by the ancients.

The ambition of these early Greek miners was not confined to alluvial mining. Numerous deeper workings have been found on the slopes of Mount Tmolus. Farther north and in a similar direction from the bay of Smyrna, similar vestiges of ancient labors are to be seen on Mount Sipylus—the modern Manissa Dagh. Thomae,[48] speaking of gold-ores in the vilayet of Aidin, refers to this locality as the one from which part of the wealth of Croesus was derived. He says that the ancient workings had not been fully fathomed, although a vertical depth of 200 ft. below the crown of the hill had been reached. The same observer calls the country-rock in these mines a trachyte, which he found to be very much decomposed in the upper levels, worked by the Lydians. Small veins, cutting across the same volcanic rock, were found to carry argentiferous galena, blende, copper, and iron pyrites with gold, all with a quartz gangue. An average sample, taken from a 1-to 2-ton lot of the ore, assayed as follows: Gold, 13 dwt., and silver, 5 oz., 13 dwt. Troy per ton; lead, 7.6, copper, 2.2, and zinc, 2.7 per cent.

The Lydians could fairly claim to be the first users of coins in history. This, in itself, bespeaks the abundance of the precious metals in that richly-endowed country. It was quite natural that accumulations of gold and silver should eventually be bartered for commodities brought from all over the world to this meeting-point of the east and the west. To stamp the metals with distinctive signs, and use them as a measure of value, was the next step, and an easy one in the ordinary course of commercial transactions.

The earliest products of the Lydian mints were issued during the seventh century B.C.; and were made, not of pure gold or silver, but of a compound of both, known as "elektron," in which the ratio of gold to silver was four to one by weight. The name is supposed to be derived from the identical Greek word, designating amber, which the native al-

35 Grote, History of Greece, vol. iv, p. 229 (New York, 1853).
36 History of Herodotus, vol. i, p. 367 (London, 1858).
37 Asie Mineure, Geog. Phys., vol. [illegible], p. [illegible].
38 Myriantheus, vol. i, p. 14, et seq.
39 Book v, chap. 98, 101.
40 Aeneid, book x, line 142.
41 Satires, book xiv, line 298.
42 Book [illegible], line 234.
43 Phoenissæ, line 601.
44 Apollonius Tyanæus, Book vi, chap. 57.
45 Myriantheus, Descriptio Orbis Terræ.
46 Compendium Chronicum, line 6228.
47 De Magistratibus Populi Romani, Book [illegible], p. 276.
[illegible] (1858).

loys of those metals somewhat resemble in color. A century later, gold and silver coins appeared; and, no doubt this change was associated with the discovery of a method of parting the two metals. Gold and silver generally occur in nature in alloys of various proportions, the character of which is particularly evident where the veins containing them are the ultimate manifestations of volcanic activity. The Anatolian gold-field, for instance, belongs to such a region of vulcanism, where gold-bearing veins, occurring in igneous rocks, carry a noteworthy amount of silver. But, apart from all extreme manifestations, the general phenomenon is, that metallic gold occurs in nature generally alloyed with silver (and not with copper). So universal and so well-recognized is this phenomenon, that the distinguished mineralogist, Breithaupt, professor of that science at Freiberg, classified native gold and native silver as one species, ranging in composition from gold with a trace of silver to silver with a trace of gold, and denied the occurrence in nature of either metal without some alloy of the other. The proportions of the two metals in native alloys vary with the composition of the minerals from which they have been reduced. It seems probable, therefore, that the "elektron" of the Lydians was simply the native alloy characteristic of their own district, and was adopted for coinage and commerce until the discovery of a method of parting permitted the manufacture of gold and silver coins separately.

THE PONTIC GOLD-FIELD.

In the northeastern portion of Asiatic Turkey, and at the point of junction of three empires, the snow-capped peak of a huge Tertiary volcano, familiarly known as Mount Ararat, rising in majestic loneliness above all surrounding eminences, marks the center of a region characterized by repeated volcanic eruptions, and the point of intersection of two main axes of high uplift. One of the latter sweeps westwardly, to form a long mountain chain which borders all the northeastern shore of Asia Minor, and within which gold-mining has been actively carried on since proto-historic times.

An interesting clue to these very ancient operations is afforded by the text of a portion of the second chapter of Genesis (vv. 10-12):

"And a river went out of Eden to water the gardens; and from thence it was parted, and became four heads.

"The name of the first is Pison: that is it which compasseth the whole land of Havilah, where there is gold;

"And the gold of that land is good; there is bedellium and the onyx stone."

By many Bible students, the river Pison has been identified as the modern Tchoruksu, running generally parallel to the east-west extension of the coast. Its valley has been since time immemorial a region of exceeding fertility, and has also enjoyed, thanks to the sheltering barrier formed by the elevated Pontic range along the northern bank of the river, the added blessing of immunity from the ravages of the bleak northern gales of Russia. It is not surprising that the combination of such advantages awakened desire for their possession in ambitious leaders of different periods; and many are the tales of struggle and bloodshed over the ownership of these gold-fields.

One of these stories is repeated by Strabo,[49] whose explorations of the then known world, at a time when traveling was beset with innumerable difficulties, have made his name illustrious among students of the geography of antiquity. It appears that Alexander the Great, perhaps remembering his father's successful mining-ventures in Macedonia, received intimations of the abundance of gold in the Sambana district, which lay in the province of Syspiritides (the modern Izpir), within the Pontic productive area. Straightway he dispatched Menon, one of his generals, at the head of an armed force, commissioning him to secure possession of the wealth-yielding territory. The sturdy natives, however, resisted the great conqueror's designs regarding lands which they justly regarded as their own, and having routed the invaders, sent back to Alexander the head of Menon, his general.

Some eight centuries later, gold-mines south of the harbor of Trebizond, in the same district, became the subject of dispute between Justinian, the mighty Byzantine emperor, and Chosroes, the king of Persia, his foe.[50] At that time the workings, operated on a very extensive scale, were furnishing abundant supplies of the precious metals for the mint at Constantinople. Much of this gold was won from placers along the banks of the Tchoruksu and its tributaries, the latter having their sources in the southern facets of the Pontic range.

Strabo's copious notes here become again instructive.[51] He says that the natives recover gold by first straining the auriferous muds through screens and subsequently spreading the undersize over sheepskins specially selected on account of their long fleece, the shreds of which would serve to entangle the particles of metal. Incidentally, it may be noted that the derivation of the appellation "Land of the Golden Fleece," by which this northeastern portion of Asiatic Turkey was designated in the oldest of the tales of Greek mythology, becomes self-suggestive. The corroborative testimony supplemented by the name of Cape Jason, applied to a nearby promontory, tends to remove all shadow of doubt regarding the exact location of that once-famous Eldorado.

The period of its original discovery, however, cannot be determined as closely as its location. The earliest known record is the mythical narrative of the Argonauts in search of the Golden Fleece; and this story yields but a single credible fact—namely, that, at some time in early Greek history, not unlikely about 1000 B.C., yet perhaps a few centuries later, a band of adventurous Greek emigrants decided to set forth and discover the country from which they had received from time to time reports of the existence of untold wealth in various forms.

There is no doubt that from that time on, and far into the fifth century B.C., the various Greek communities were actively engaged in the exploration and colonization of the regions lying east of their mainland. Such expansions in the course of a national growth have invariably been the consequence of prosperity at home. It is not inconceivable that some of the hardier and more indefatigable of these explorers surmounted the hardships attending travel on the turbulent waters of the Black Sea, and succeeded in reaching portions of its southeastern shores. What they saw there may be inferred from the tales which they brought back, enriched with the adornments required to fire the imaginations of their countrymen.

According to the version of Pliny,[52] Strabo's younger contemporary, and one of the best known naturalists of antiquity, the Colchis, as he calls the Land of the Golden Fleece, was ruled, previous to the coming of the Argonauts, by Selances, a descendant of Actes. This ruler is said to have discovered extensive gold-placers in the territory inhabited by the Suanes, who lived within the pale of the Colchides. "The whole country, however, is renowned for its gold-fields," is Pliny's final comment in connection with this description.

PROSPECTS OF THE FUTURE.

To our own generation the point of greatest interest in connection with any of these gold-fields lies in the possibility of a resumption of exploitation of the hitherto abandoned workings. This does not necessarily imply that gold will again be the chief metal recovered. There have been numerous instances where mines, at one time gold-producing, have eventually turned out to be

49 Book xi., chap. 14 19.
50 Gibbons, Decline and Fall of the Roman Empire, vol. iii., p. 579.
51 Book xi., chap. 2.
52. Book xxiii., chap. 15.
53. Eng. & Ming. Journal, vol. lxxxix., No. 14, p. 713.
54. Mng. & Scientific Press, vol. xcviii. No. 24, p. 821.

great producers of copper. Two noteworthy instances of such a sequence are furnished by two of the world's present deposits of low-grade copper sulphides: the Mount Lyell mine in Tasmania, and the Rio Tinto in the Spanish province of Huelva. The former came into prominence in 1881, and began to attract attention as a gold-producer in the incipient stage of its development.[53] With regard to the latter, Strabo, to whom frequent reference must perforce be made in connection with ancient mining, has given us an enthusiastic account of the gold-production in southern Spain on the site of what are now the famous and immensely productive copper-mines of Rio Tinto.

Another instance of the same nature occurs at the Mount Morgan mine in Australia. Here the ore at very shallow depths was rich in gold and carried only insignificant quantities of copper. Lower down, however, the percentage of the latter metal grew considerably higher.

There are some signs of the recurrence of the same phenomenon in the Pontic gold-field. Copper has been mined during the past few centuries at various points within this metalliferous province. Although these operations have been desultory, there is ground to suspect the existence of a rich copper-belt parallel with the northeastern coastal development of Turkey in Asia. Kerassons is, among others, a noteworthy locality in which copper-ores in large bodies have been reported on various occasions.[54] The recovery of gold as a by-product in the smelting of such ores is by no means impossible.

Work on the Anatolian gold-field, on the other hand, has remained practically at a standstill since the beginning of the Christian era. Perhaps detailed investigation of the region will lead to interesting industrial developments; and, while these ancient gold-fields may never again yield such quantities of the precious metal as they gave to the miners of antiquity, they may produce, through development at lower depths, of the baser metals, a greater treasure than they conferred on former generations.

PROSPECTING THE YUKON

The "cheecaco," or newcomer, entering the Yukon to prospect should receive a little preliminary instruction before launching into the wilderness, says Robert Henderson, discoverer of gold in the Yukon Valley, in a letter to the Dawson Weekly News. He cannot start into the Yukon to spend the winter without enough money to defray the cost of a winter's outfit. If he leaves Whitehorse in the summer, the trip down the Yukon river may be made by steamer or in small boat. It always is easy to arrange accommodation. By buying in a Canadian town, goods entering the Yukon will not be subject to duty, but it is best, all things considered, to buy an outfit in Dawson; or, for one not coming into Dawson, to buy at Whitehorse. By buying in this territory, he has the benefit of experienced and scrupulous traders, who know just what is adapted to this region, and who will assist in selecting the best for the peculiar work to be undertaken.

The prospector should leave Dawson in August or September. At this time the summer floods are over, flies are less troublesome, and game and fish are plentiful. Whenever possible, the prospector should go by boat. (For shallow, swift and narrow rivers, a boat 30 feet long, of 26-inch bottom, and 22 inches deep is the best. Having procured his boat, 150 feet of ½-inch hemp rope, and a pair of rubber boots, the prospector next selects and loads his provisions, always bearing in mind that articles less likely to be damaged by water hould be placed in the bottom of the boat.

The outfit for twelve months should comprise the following: Flour, 500 lbs.; rolled oats, 150 lbs.; cornmeal, 50 lbs.; beans, 7 lbs.; sugar, 125 lbs.; Lubeck potatoes, 60 lbs.; butter, 50 lbs.; apricots, 25 lbs.; prunes, 25 lbs.; apples, 25 lbs.; milk, 2 cases; cream, 2 cases; ham, 25 lbs.; bacon, 50 lbs.; salt, 15 lbs.; pepper, 1 lb.; syrup, 5 gallons; baking powder, 2 lbs.; baking soda, 2 lbs.; yeast cakes, 6 boxes; soap, 12 lbs.; best pilot bread, 30 lbs.; candles, 2 boxes; tobacco; best woolen underwear, 3 suits; thick overshirts, 3; thick woolen sox, 12 pairs; German sox, 2 pairs; woolen pants, 1 pair; overalls, 3 pairs; felt shoes, 1 pair; rubber shoes, 2 pairs; moccasins, 3 pairs; insoles for moccasins, 6; snowshoes, 1 pair; pack straps, 1 set; eyeglasses, colored, 1 pair; good field-glasses, 1 pair; reliable compass; fur robe; fur cap; canvas jacket; sweater; axes, 2; small camp ax; auger, ½ inch, 1; crosscut saw, 4 feet; whipsaw; jack-plane; nails, 15 lbs., 10-penny; clawhammer; flat files, 2; sheath knives, 2; three-cornered files, 2; sharpening stone; picks, 2; shovels, 3; gold-pans, 2; Yukon stove with oven or drum; 30-30 Winchester rifle; good shotgun; 200 rounds for shotgun; 200 rounds for rifle; frying pan; knife, fork and plate; small pots, 4; large enameled mugs, 2.

The outfit should include a small medicine chest, among the contents of which should be one box of carbolic salve and a half-pint bottle of peroxide of hydrogen or other equally good antiseptic. One gallon of concentrated lime-juice should be taken along to make a pleasant and invigorating drink, and it will be a most effctual preventive of scurvy. The tent should be 10 by 12 feet in size. It serves, when not in use, to cover the outfit, a precaution that should never be neglected either in the boat or in camp.

The prospector will have no difficulty in providing himself with fresh meat. The country abounds with moose, bear, caribou, mountain sheep, geese, ducks, ptarmigan, partridges, and grouse, and cranes and swans alight on the bars of the upper rivers by the thousands. Beaver, land otter, marten, lynx, wolf, fox, wolverine and other fur-bearing animals are plentiful around the upper reaches of Yukon side streams.

On the trail in severe weather, always make camp while there is plenty of daylight. Never travel in foggy or stormy weather; always have matches and dry birch-bark ready to make a fire quickly. Eat regularly, even if you are not hungry. Keep your hands and feet dry, and —don't forget your tobacco.

It is well on a trip of this kind to take two or three good dogs and a Yukon sleigh. The dogs cost little to feed in a game country. The sleigh can be packed in the boat and will be useful for moving camp from creek to creek. Make a good warm shelter for the dogs and feed them at night.

To keep the outfit while in camp, cut four trees a few feet apart and 12 feet from the ground. Pick off the bark, and build a platform on top and let it extend about three feet on each side beyond the supports. Place supplies on top and cover with canvas and spruce boughs. They are in this way protected from animals.

In building a cabin, make it big enough. It takes little longer to build a cabin 16 by 12 than one of less dimensions, and this is large enough for all requirements. Level off the ground, and let the first logs be imbedded in it. Cover well with moss and lay the next log on top, and so with each log until the walls are six feet high. The logs forming the gable must be pinned together with 1½-inch wooden pegs, and the ridge-pole laid in place. A smaller log on each side of the ridge-pole further supports the roof, which is made of poles three or four inches in diameter, laid side by side and covered with moss and earth. Whipsaw a few boards to make a door. Pieces of moose skin make good hinges, and a clean flour sack steeped in melted tallow or oil makes a good substitute for glass.

Your partner on a prospecting trip should be a man with whom you are well acquainted, and of jovial and optimistic disposition. Avoid arguments, especially of a religious or political nature, and the golden adage, "A kind word turneth away wrath," is nowhere so forcibly realized as in the wilderness.

THE GREAT COBAR MINES

MINING & ENGINEERING REVIEW.

Next to Broken Hill, Cobar is the most important metal mining center in the State of New South Wales, and the future of the town and district is wrapped up in the fortunes of the Great Cobar, Ltd. The mines owned by this company are the Great Cobar Cobar Gold (Fort Bourke), Chesney Copper, and, some six miles farther south, the Peak and Conqueror gold mines. Midway between the Great Cobar and the Peak is the Occidental gold mine. Apart from the foregoing, any other mines in the immediate vicinity are either unworked or operating on a very small scale.

The predictions of Mr. H. C. Bellinger, the general manager, are that the annual production of the mines will shortly reach 10,000 tons of copper, 50,000 ounces gold, and about 250,000 ounces silver per annum. For many years the Mount Boppy G. M. Co., at Canbelego, some thirty miles from Cobar, held the record as the largest gold producer, but now that the ore from the Fort Bourke mine is being treated, the Great Cobar, Ltd., holds the pride of place, both in regard to copper and gold. The following table shows the output during the last six years:

OUTPUT OF GREAT COBAR MINES.

	Ore raised.	Blister.	Value.
1906	198,168	4,030	.....
1907	167,005	3,459	.....
1908	234,877	5,127	334,251
1909 (10½ mos.)	203,746	4,855	378,842
1910 (10½ mos.)	298,652	6,248	524,000
1911	346,303	6,548	366,688

From 1876 to end of 1911 the production of copper stands at 89,009 tons.

In order to show that the returns are steadily increasing, the figures for the first five months of the present year may be quoted:

	Copper. Tons.	Gold. Oz.	Silver. Oz.
January	423	2,250	16,751
February	504	2,180	13,767
March	576	3,920	23,716
April	583	5,147	32,744
May	701	5,137	21,561

The main shaft at the Great Cobar mine is down to a depth of 1,400 feet. Its dimensions are 15 feet by 8 feet, in three compartments, two of which are for hauling, and one for pumping, air pipes and ladder way. The shaft is equipped with a pair of coupled horizontal expansive non-condensing Corliss valve winding engines by Andrew Barclay & Sons. Cylinders, 22-inch diameter by 48-inch stroke; winding capacity, 2,000 feet per minute, with a two-ton load of ore. The drums are 10 feet in diameter by 4 feet, and are fitted with steam released friction clutch and hand brake.

The head gear is 67 feet in height to the center of the winding sheaves, and is constructed of steel sections. Each cage lifts two 16 feet cubic feet capacity, box pattern mine trucks to the brace, and lands on chairs. The trucks are then pushed over the bin and tipped by means of a rotary tippler into the brace bin, which holds 450 tons. From this bin the ore is fed through pneumatically operated doors to two Hadfield-Heclon gyratory breakers, then over the picking belts and into the bedding bins. From here it is moved by wagons, and a small portion from each wagon is loaded into a special truck, which, when full, is delivered to the sampling mill.

The Sample Mill.—The ore is deivered to a Babcock and Wilcox tray conveyor of the endless chain end discharge pattern, having a capacity of 50 tons per hour at 45 f.p.m. This delivers onto a similar conveyor rising at an angle of 20 deg. This conveyor delivers to a No. 5 McCully gyratory ore discharger into a 30-ton capacity steel hopper ore breaker. The ore is then lifted by a belt elevator (66 feet centres), which delivers to a 64-inch Simplex sampler, 15 per cent cut. The sample then gravitates to a No. 3 McCully crusher. This delivers to a 44-inch sampler, 20 per cent cut. The sample then gravitates to a 24-inch by 14-inch rolls, 69 r.p.m. It is again sampled with a 28-inch sampler, 15 per cent cut, and again passes to another set of 24-inch by 14-inch rolls, 144 r.p.m. The product then passes to a 28-inch sampler, 15 per cent cut, and from there gravitates to a sample grinder.

Before briefly describing the smelting equipment, a few words may be written regarding the company's mines.

MINES OF THE COMPANY.

The Great Cobar Mine.—According to Mr. J. E. Carne (assistant Government geologist), the Cobar lode consists of three lenses, extending in a N. 10 degree W. direction, with a slight dip to the east. The center or principal lens has an average length of about 45 feet, and a depth of about 70 feet (the maximum being 120 feet at the 800 ft. level). The north lens is separated from the center by 140 feet of mineralized slate carrying low-grade ore. Its length, so far as proved, is 300 fet, and its width 90 feet. The south lens is separated from the center by a blank of about 50 feet in the upper levels, but merges into it below No. 3 level. Its width averages 50 feet, the maximum being 75 feet in No. 7 level and its greatest length 150 feet. South of this lens the ore dies out in country, though slight metal values and quartz leaders continue in the rubbly channel slate.

The ore lenses are simple impregnations and replacements in slate and fine sandstone, with more or less quartz in place. Iron and copper sulphides occur solid for the most part, but are occasionally mined with slate and quartz, the north lens being especially basic even where low in copper. No true eastern wall exists, the ore dying away gradually in the country, and in the mineralized slates between lenses. A marked distinction, however, is noticeable between the channel slate and the west country, the latter being more jointed and blocky.

During the reorganization of the surface plant, development work underground has been pushed ahead, and the ore reserves exceed 2,000,000 tons, averaging 2.6 per cent copper and 1 dwt. gold.

The Cobar Gold Mine.—The next most important mine, although the most recently secured, is the old Fort Bourke, purchased from the Cobar gold mines in 1910 for the sum of £120,000. The Cobar Gold Mines, Ltd., was registered in 1896 and reconstructed in 1898. The plant included a mill of 100 stamps, and, when the ore became too refractory to treat by amalgamation, something like £80,000 was frittered away in fruitless experiments. When the company shut down the ore reserves amounted to 141,053 tons, assaying 1.3 per cent copper and 10.5 dwts gold. The ore is now dumped into large storage bins and railed to the smelters as required. The total output of gold to the end of 1907, according to official returns, was 113,509 ounces, valued at £351,101, and the present production is approximately 3,000 ounces per month.

The ore reserves total some 350,000 tons, averaging 1.5 per cent copper and nearly 10 dwts gold. No dividends were ever paid by the old company, but the mine will go a long way towards providing an adequate return to the present holders.

The Chesney mine was originally worked as a gold proposition, and a large quantity of the auriferous slate from the oxidized zone was treated by battery and amalgamation, the outcrop betraying no evidence of the copper ores below. In 1901, about 4,500 tons were treated at the Great Cobar smelters, for a return of 3 per cent copper and 1 dwt. gold per ton; and in 1904 the property was purchased by the present owners. The shaft is 800 ft. deep. At the 464-foot level the ore body has been worked for a length of over 800

feet, with an average width of nearly 40 feet. The Fort Bourke ore, being richer in gold, now forms the main siliceous flux, and consequently the reserves at the Chesney mine are not being extracted on a large scale. The ore reserves total 750,000 tons, averaging 2.7 per cent copper and 1 dwt. gold. The value of the Chesney southern ore body at Nos. 6 and 7 levels south is, however, nearly 4 per cent copper and 6 dwts. gold.

The Peak mine s also a valuable property, and has been a consistent producer for the past eighteen years. Last year what is apparently a continuation of the lode was discovered, containing high gold and silver values. Further development work is being carried out to determine the tonnage available. All the mines are under the management of Mr. Nicholas Treloar.

SMELTING DEPARTMENT.

There are four blast furnaces, each 240 inches by 56 inches, at the tuyeres, with a total capacity of 2,000 tons per day, although at preesnt the average does not exceed 1,250 tons. The proportion of ores from the various mines used in the furnace charges is approximately four parts of Cobar ore to one part of siliceous ores from the Cobar Gold, Chesney or Peak mines. No ordinary furnace slag is used on the charge, but the converter slag is retreated to recover its values. When the scheme of reorganization is complete, and production on a large scale commenced, the output will perhaps exceed the figures mentioned by Mr. Bellinger. The only other factor is the price of copper, and at anything like present figures large profits can be earned.

There are two tiers of water jackets, five upper and five lower, 10 feet by 4 feet, with 5-inch water space on each side, and one upper and one lower at each end. The bussel pipe supplying 40 tuyeres is 34 inches in diameter, whilst the blast main is 42-inch diameter. The height from ground to tapping floor is 8 feet 6 inches; from tapping floor to charging floor, 26 feet 6 inches; from charging floor to top of superstructure, 16 feet 3 inches; from top of superstructure to top of auxiliary stack, 34 feet; from top of superstructure to top of down-take, 19 feet 6 inches; from ground to top of auxiliary stack, 85 feet 3 inches.

The furnace charge cars are 34 and 44 cubic feet capacity. They are hauled up the incline by a motor-driven geared winch, capable of hauling eight tons up a gradient of 1 in 8 at the rate of eight tons per hour.

The molten metal from the furnaces is continuously run into forehearths or settlers. Originally, five circular settlers, 18 feet in diameter and 4 feet 6 inches deep, capacity when lined 389 cubic feet, were installed, but now only two of this type, those at the extreme ends, are retained. Between the furnaces, where one circular settler was formerly used, two of the oval type has been placed, making a total of eight. The dimensions of these latter are 9 feet 6 inches by 4 feet 6 inches, capacity 270 cubic feet. From these forehearths the slag forms a continuous flow on the east side, delivering into slag pots. The matte is tapped intermittently on the west side (which is the converter building) into eight-ton segmental matte ladles.

There are four standard improved Berg cinder cars, 200 cubic feet capacity, 80,000 pounds capacity, fitted with automatic couplings. The slag pot is supported directly within the C.I. trunnion ring, and is tipped to either side of the track by forged worm and cut gears electrically operated. There are also three Dewhurst's patent side-tipping slag ladles and cars, with split ladle. Capacity of ladle, 280 cubic feet.

The converters are of the barrel type, 84 inches by 126 inches, carrying 14 tuyeres. There are three blowing stands, set end to end, and blowing into a common flue, with dust chamber inserted along the flue. The gases from the converter pass into hood; from hood into C.I. flue; from C.I. flue to dust-settling chamber to brick down-take; then through underground flue to fume scrubber; from scrubber to brick stack. The converters are handled by two forty-ton electric overhead cranes manufactured by Messrs. Babcock & Wilcox, Ltd. These cranes will hoist 40 tons at 16 feet per minute. Transverse traveling, 110 f.p.m.; longitudinal traveling, 250 f.p.m. Span of crane, 49 feet 8 inches, center to center of rails. Height from ground to top of crane rail, 36 feet. Crane controlled by driver in cab, traveling with main girders. Each crane is fitted with an auxiliary hoist of five and ten tons capacity.

Mr. F. J. Murphy, who has had experience on all the principal smelters in the United States, is in charge of the furnaces.

POWER GENERATION.

The power generating station is not by any means the least important section in such an undertaking. The boilers, numbering six, each having a heating area of 3,580 square feet and a grade area of 70 square feet, are of the Babcock & Wilcox make, fitted with chain grate stokes and superheaters. The coal is unloaded direct into a steel hopper, the top of which is at rail level. This hopper feeds direct into a B. & W. four-roll coal crusher, from which the coal gravitates to the rotary feeder, which feeds a B. & W. standard gravity bucket conveyor. This conveyor elevates the coal over steel hoppers, set over and in front of the boilers, which deliver through doors to the mechanical stokers. The conveyor buckets are dumped by means of mechanical dumpers over any of these hoppers. The conveyor then returns under the boiler-room floor, where the ashes are loaded into same. When ashes are being loaded all the buckets are dumped over the ash hopper, which delivers into railway wagons.

Steam is supplied to three Browett-Lindley forced lubrication, three-crank, three-cylinder, triple-expansion, vertical engines, each of 250 i.h.p. They are directly connected to three Siemens' three-phase alternators, each 300 kw., 355 k.v.a., 440 volts, 50 periods, 375 r.p.m., directly coupled to F type, direct current exciters, to supply the necessary excitation current for the above alternators at 100 volts.

Direct current is supplied by two three-phase sychronous motors, fitted with slip rings, at 380 r.p.m. on a 440 volt, 50 period circuit, direct coupled to two compound wound, continuous current generators to give 250 k.w., or 1,040 amperes, at 240 volts. This current is used for the electric locomotives, winding winch, lighting, etc.

The blast for the funaces is supplied by four Morley's patent horizontal tandem compound engines coupled to two Conersville special smelter blowers, 48 inches by 78 inches by 96 inches, and with a capacity of 36,000 cubic feet of air per minute at a pressure of 42 ounces per square inch. The converters are supplied with air by a Walker Bros.' cross compound Corliss engine, coupled in straight line with direct acting reciprocating blowers. The capacity of this plant is about 9,000 cubic feet of air per minute, at a pressure of 36 to 48 ounces.

There are two air compressors in the same building for supplying power underground and to a number of pneumatically operated hoists and other devices about the surface plant. These are also by the firm of Walker Brothers, Wigan, England. The i.h.p. of each engine is 350

SUMMARY OF COSTS PER TON.

Cobar mine, 1908, 8s 11:30d; 1909, 8s 4.08d; 1910, 8s 7.25d; 1911, 9s 5d.

Smelting, 1908, 11s 4:30s; 190, 9s 4.10d; 1910, 8s 9.36d; 1911, 7s 5.26d.

Converting, 1908, 2s 2.61d; 1909, 2s 7.20d; 1910, 1s 9.24d; 1911, 1s 8.62d.

It may safely be assumed that the figures for the current year will show a reduction on those above quoted, bringing the operating cost below 18s per ton.

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CONTENTS:

ON THE RAGGED EDGE

On the 15th of the present month, according to a report brought in from Bingham, two of the Utah Copper Company's steam shovels were "shot off their perches" on the precipitous mountain side and hurled several hundred feet down into the "big pit," which is evidently a catch-all for everything that fails to stick on the ledges above, where the enlightened "greaser" blasting crews are said to be rapidly effacing all traces of the stripping levels in their efforts to provide broken rock of some sort to the company's mills. And this suggests the thought that the management might conserve its "stripped resources" and the means of getting at them -for a time, at least- by taking the shovels around on the Wall side of the hill and utilize them in scooping up the millions of tons of rock previously there deposited and sending that to the mills. It could be "sweetened up" with Boston Con. and Barnsdall underground ore (if there is any recoverable quantity left) just as the product from the "stripped area" has been sweetened, and probably make just as good a showing. Present exigencies would seem to justify a trial of this kind, anyhow.

MESSRS. GUGGENHEIM ARE SEEING THE LIGHT

Congratulations to Daniel Guggenheim and his intimate associates, for the manner in which they are casting aside the vainglorious notions and schemes of "banker and brokerage-made" engineers which have burdened their careers in the world during the past five or six years, seem to be in order. Of course, they have taken but few steps in the new direction as yet, but news of the past few weeks indicates that they have finally seen a new light and that their emergence from the current that was swiftly sweeping them toward the maelstrom in which public contempt and financial oblivion seemed waiting to engulf them, will take place with accelerated speed from now on.

Until just recently, it has been common talk for a long time that the latest Guggenheim flotation—the Braden Copper Company —was in danger of collapse; that the proposition had had FAILURE stamped upon it in large letters. The same extravagant schemes for mining and the same or similar methods of ore-dressing that was characterizing the malpractice and administration of other propositions in which they had become largely interested in this country and in Alaska, were being applied in South America, and while claims of success were being hurled broadcast, these claims and the accompanying intimations that much additional financing would be necessary before the dividend period could be reached, did not fit well together. The public was suspicious, and Braden's star was not twinkling very brilliantly. A big milling plant was constructed and started on its career, but the grade of product turned out and the percentage of recovery of the copper contents of the ore were alike unsatisfactory and discouraging.

Recently there must have been a shaking up in the company's policy for announcement was made that a new process of treating the ore was to be tried out at the mill and that much was expected of it, comparatively speaking. From time to time reports of progress have been made and now—during the past month—the good news has been coming that through the application of the new methods success is assured. In an article dealing with the company's affairs the Boston News Bureau of the 18th, it is said:

> The Mineral Separation Company's process which has been [illegible] eral units of the mill has given satisfactory results and should materially increase the extraction. Braden's recovery has been running as low as 50%, while the Sepulveda Co. process [illegible] after the first of the coming year, the Braden plant should have been so altered and remodelled as to permit of the treatment of 3000 tons of ore daily.

Now that the Messrs. Guggenheim and their associates have displayed courage enough to make radical changes at the Braden, and to such good purpose, the thought suggests itself that there is still hope that something may be done to save Utah Copper from going the remaining short distance on the direct route to Hades. Of course, it is hard to conceive how the management can be persuaded to make changes and introduce methods and processes into the Magna and Arthur mills that were not worked out and "perfected" by the company's own peerless engineers; but maybe the Messrs. Guggenheim, who own about one-fourth of the company's issued shares, can wield influence enough to force action. Accomplishments at the Braden ought to point the way.

Another evidence that the Guggenheims have tired of the game they have been forced to play in conjunction with a combination of manipulators, is also found in the Bureau of the 14th instant. The announcement, printed in part herewith, shows that the Guggenheims have joined Albert C. Burrage, of Boston, in the handling of the latter's copper enterprise at Chuquicamata, Chile, and that methods of treating the ore are being worked out without consulting the great engineers who have brought stagnation to the market in other propositions heretofore thought so much of by them. Concerning the new Chile enterprise the News Bureau says:

> The [illegible] facilities through a six-mile branch of the main line of the Antofagasta & Bolivia Railway.
>
> Some of [illegible] two years [illegible] has secured all the additional necessary mining property in the district, and sufficient [illegible] all the [illegible]

according to some 30,000 horse power, on the Loa river, twenty miles from the Chuquicamata mines.

The Chuquicamata copper deposit is very large and most unusual in character, its clearly-defined, uniformly-mineralized surface covering an area 8000 feet long and over 1000 feet wide. The ore is one of nature's freaks, being composed, at the surface at least, almost wholly of the basic chloride of copper called "atacamite," after Atacama, the Chilean province in which it is found, the ordinary sulphate of copper, called chalcanthite, and the basic sulphate of copper, called brochantite.

For many months six churn drills have been at work drilling the deposit, but no statement has yet been made as to what the drills have disclosed or as to the tonnage or copper contents of the ore. It is fair to assume, however, that both are at least of fair grade, inasmuch as the property has now been bought and paid for.

This property has been known to the copper world for many years and has caused much discussion among mining engineers and metallurgists on account of the peculiar nature of the ore, which is unsuited to direct smelting on account of the loss of copper through volatilization, due to the chlorine in the ore, and is also, on account of its fineness, unsuited to ordinary mechanical concentration.

It is, however, especially adapted to leaching.

The deposit has also hitherto been considered difficult to handle because situated in a desert fifty miles away from any available water supply, and, because, owing to the scattered Chilean ownership, it was practically impossible to raise money for piping, in a large way, the water from the mountains across the desert to the mine.

The altitude is 9500 feet above sea level, and the climate is very healthful, snow and rain being practically unknown.

The property is especially suited to steam shovel mining, for the ore comes to the surface without any capping of non-payable material, and is easily broken down, its local name being "llampera," which means a friable ore.

It is understood that both Mr. Burrage and the Messrs. Guggenheim have separately spent much time and money in working out satisfactory methods for treating the ores.

The property is now being conveyed to the Chile Exploration Co., which will be a close corporation, owned and officered solely by the firm of M. Guggenheim's Sons and Mr. Burrage. Daniel Guggenheim will be the president and Mr. Burrage vice-president. It is also said that neither the American Smelting & Refining Co. nor the Guggenheim Exploration Co. are in any way interested in the enterprise and that no public or private flotation of the company will be made.

WORK AT ALASKA GOLD MINES

George O. Bradley, consulting engineer for the Alaska Gold Mines company, returned from a trip to Alaska about the middle of the month. Commenting on his return and in quoting him, the Evening Telegram of this city says: "In all $3,000,000 is to be spent by the mining company in PREPARING to develop its properties in Alaska. Todate, according to Mr. Bradley, more than $1,000,000 has been expended." In another portion of the interview the paper makes Mr. Bradley say: "Everything is UNDER COVER for the winter, but we are PREPARED TO BEGIN WORK in the spring in earnest." In opposition to this, the Boston Market Letter of Hayden, Stone & Co., of November 1, says: "Five hundred men are now at work in the various divisions of this property, developing the mine underground and doing the surface construction and development work preliminary to the erection of the company's 6000-ton mill. * * * A crew of experienced tunned men has been secured and the driving of this (the Sheep Creek) tunnel, which will be one of the main pieces of development work, WILL BE PUSHED WITH ALL EXPEDITION." All of which is "hot dope," any more than some arrangement ought to be made by which reports can be made to jibe. And for fear that you "investors" will not realize fully just what you are buying, when you get into this proposition, let us suggest that you again read the "report" of Messrs. Jackling and Holden, once more reproduced on another page of this issue.

MAMMOTH MILLING PLANTS

So much is written and said about the mammoth capacity of the concentrating mills of the Utah Copper company, at Bingham, that an impression prevails everywhere, almost, that they are the biggest things of the character in this country. A capacity of 12,000 tons a day is claimed for the Magna plant and 8,000 tons a day for the Arthur. This means a total of 20 000 tons in twenty-four hours for the combined output.

Beginning on page 67 of this impression is an illustrated article describing the concentrator of the Oliver Iron Mining company, at Coleraine, Minn., and the plant of the Wisconsin Steel Co., at Nashwauk, Wis. The former of these mills works up 35,000 tons of crude ore in twenty hours, which is just about double the capacity of the combined mills of the Utah Copper company. Taking the output of the two mills described, and it is seen that the capacity is much more than three times as much as the combined capacity of the Magna and Arthur mills.

Of course, in the concentration of the iron ores no resort is made to fine grinding, such as that done at the Utah Copper mills. But seeing that the latter company is always prating about the immense tonnage it handles, and, as the practice followed only results in a recovery of about one-half of the copper contents of the ore, why would it not be a good scheme to throw out the fine grinders and adopt the Oliver Iron company method? The capacity for tonnage thus secured would sound well in the stock market and the results attained in the matter of recovery would probably be about the same.

IN IMMACULATE ROBES

The mining department of the Salt Lake Tribune of the 21st carried a story to the effect that there was a likelihood of the Giroux and Ely Mines companies properties being merged with the Nevada Consolidated and made an additional holding of the Utah Copper Company; that the scheme was to issue more Utah Copper shares and trade them for Giroux and Ely Mines stock. In this way, it was declared, the present most cordial relations between the Cole-Ryan crowd and Utah Copper would be more firmly cemented. Not being endowed with the gift of revelation to the extent that most Utah editors appear to be, we are unable to either affirm or deny this latest attempt to slip immaculate gowns on to the shoulders of the Utah Copper crowd; but, we shall be curious to see how things look when the Cole-Ryan-Amalgamated household of real copper miners assent to the handling of anything now controlled by them in the grotesquely loud fashion that lends so much distinction and grace to the harlequin movements of Utah Copper, Ray, Chino, Butte and Superior and Alaska Goldmines at the present time.

COLLEGE MEN UNDERGROUND

As economic underground operations continue to involve more and more the principles of scientific management, the question of what class of men is best fitted to direct these operations seems to become more and more important, says Theodore V. K. Smith, a mine "Captain" of Mineville, New York, in a letter to Engineering & Mining Journal. At most of the larger mines the men eligible for the more important positions, are, in general, of two classes: "Old timers" or practical men and the college men with a good education and more or less practical experience, the former naturally far outnumbering the latter. Between these two classes a choice must inevitably be made, by the larger mining companies at least, as to which shall fill these before-mentioned more authoritative positions.

It is frequently said by college men after having underground experience that they "learned more about mining in their first year out of college than they did in all their four years in college." This may be perfectly true and it is believed that most college men will admit it, but it is probably the training they received during their college years that fitted them to learn faster and better when later they actually "got their nose in the muck." Any reasonable man will also admit that a college course, if taken seriously, trains any man to be systematic, and in up-to-date mining this is, of course, a fundamental principle, no matter what position a man may occupy. An "old timer" may be systematic (most

of them are very much so) but it takes him longer to learn than it does a college man, and if conditions change and it is necessary to learn a new system or adopt new methods, there is hardly any comparison to be made between these two classes as the difference is so great. In other words, an "old timer" adopts a system merely because it is easier for him to work by rule of thumb; but a college man sees the reason for it and is, therefore, quicker to see how improvements can be made by a change of system.

At the larger mines in the United States where accurate costs of all underground operations are kept, it is difficult for the average "old timer" or practical man to understand or realize the importance of such terms as: "Cost per ton powder," "development cost per foot labor," "tons per man per day," etc. An understanding and realization of the importance of such terms and methods of cost keeping, of course, enable the operating men to know what the different classes of work and supplies are costing in their different working places, and such knowledge makes it possible for them to make comparisons and to reason out the source of leaks, making their work more efficient accordingly. A lack of knowledge concerning how these figures are arrived at and what they amount to means that such a man might very easily overlook an important leak or a wasteful expense for a long time before he knew what was really the matter. Of course, many companies do not make a practice of allowing their operating men to know the cost details of their work, but it is, however, common practice at the better managed mines to let the operating men know approximately what they are doing in this respect and to govern their work accordingly.

The attitude which "old timers" take toward such methods is well illustrated by a remark heard recently from an old practical man who has spent many years underground. "Figuring may be all right but you can't put ore in the skip with a pencil." As has been said, it is, as a rule, hard for the "old timer" to understand the truth and importance of figures, whereas the technical or college man has been trained in that direction and it should come natural to him.

A college man can learn much from a practical man and the knowledge he acquires from such sources and from experience will gradually develop him into what might be termed a "practical technical man" which is indeed the happy combination of the two. On the other hand it is difficult for an "old timer" to learn anything from a college man and it is, therefore, almost impossible for him ever to understand more than the most elementary technicalities. It goes without saying that there are many exceptions to this statement, some of which are noteworthy in many respects; but as a general rule this condition of affairs is believed to be true.

The ability to handle men is largely a temperamental gift and is as likely to be found in the college man as in the practical man. However, one of the secrets of this ability is to know what a fair day's work is, and probably most mining men will agree that this knowledge is to be gained in no other way than from practical experience. A college man who has never been on the business end of a "muck stick" himself or who has never done his trick at the crank of a machine is certainly in no position to dictate how many cars a mucker should muck or how many holes or feet is a good shift's work for a drill runner. There is nothing more ridiculous on the face of the earth or more properly, under it, than a green college man giving orders and laying out work which he has never done himself.

In such cases a college man will probably demand an unreasonable amount of work from one man and lay out something so absurdly easy and simple for another that the first will generally be justly disgusted and not do so well as he otherwise would and the second will, in nine cases out of ten, "throw a bluff" and "taper" most of the shift. In neither case is the man working efficiently. Therefore it is believed that the best thing a recent technical graduate can do, who intends to follow the operating end of mining, is to subject himself to a year of two years good stiff grind as mucker, machine man, timberman and under-boss of some sort provided he has luck enough to get such jobs and sand enough to hold them. Furthermore, a college man who has not done such work cannot be of much use in the underground operating department of any good mining company.

Another point in favor of long practical experience is the sound judgment it gives, which is required in cases of bad ground, the weight of heavy or moving ground on timbers, the drilling and breaking qualities of different formations and many similar details. The "old timer" can be relied upon to be almost correct in his opinions of such things and although some of the questions which come up in such circumstances are really no more than guesses, the "old timer's" guess is far more apt to be right than any college man's.

A practical man with no college education will work, as a rule, for less wages for a longer time than a man who has been technically educated. The college man calculates that his years of training in a scientific school entitle him to better pay than that received by the "old timer" and he will generally consider himself worth more to the company whether he is or not. As a rule, the "old timer" is more faithful to his employers than the average college man is apt to be and is generally more satisfied with his work, for the reason that a college man looks for rapid advancement while the "old timer," as long as he receives fair wages, is satisfied. Most mining men realize and appreciate the fine loyalty and pride which nearly all "old timers" show and feel for the company which employs them and doubtless most of us can call to mind not a few examples of the fine old men who have spent the best years of their lives in the interest and service of their employers and whose faithful efforts have contributed not a little to the success of mining companies, large and small, throughout the mining countries of the world.

The main points in the foregoing paragraphs may be summarized as follows: (1) The ability of college men to learn fast, to be systematic, to reason clearly and to adapt themselves and their work to changing conditions. (2) The ability of college men to calculate and realize the importance of figures. (3) The possibility of a college man's developing himself into a "practical technical man." (4) The lack of ability in a college man to direct work for others which he has never done himself. (5) The better judgment of the "old timer" in details which can be gained only from long experience. (6) The superior faithfulness of the "old timer" to his employers.

In conclusion it may be said that whether a man is a college graduate or not, the fact remains that the ideal operating man for the efficient mining of today is the one who has good sound common sense, good practical experience, and education and brains enough to handle the technical problems which come before him. Such a man may either be a college man who has gained his technical knowledge in some good scientific school and, to learn the other side of it, has had sense enough to humble himself to a period of good stiff underground labor, or, he may be a practical man who has educated himself sufficiently and who, through hard work and study, has developed into the ideal combination. Statistics would probably show that cases of the former kind are more numerous than the latter and, in view of the economic conditions required in underground operations today, it is therefore believed that the college man is destined to be given the preference

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Peacock copper is the common name of bornite.

Editorial And Other Notes

On election night a lady who had been watching the bulletin returns telephoned to the folks out home that the result was "a landslide for Woodrow Wilson and Joseph F. Smith—Wilson in the country at large and Joseph F. in Utah."

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Readers will miss in this issue Mr. W. L. Austin's serial article on the "Leaching of Copper Ore." In a letter he explains that professional work has so completely commanded his time during the past month that he was unable to finish his November contribution. He expects to complete it in time for the December number.

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Chino is going to $60 or $65 and Butte & Superior to— —. Thus runs the tip (private and confidential, of course). Also it is said that Chino's cost of producing copper will be nothing at all and that zinc will sell for 10c. per lb. The gullible may believe what they please and the lambs will continue to be meat for the bulls and bears.—"By the Way" man in Engineering & Mining Journal.

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Cyanide rash may be relieved by applying a mixture of 3 oz. of camphor dissolved in one pint of olive oil, by heating. This complaint is mainly external, that is, the condition of the blood has little to do with it, as perfectly healthy men are troubled, and medicine is not necessary. Another treatment is the application of a fairly strong solution of potassium permanganate, which dries up the rash in quick time.

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There evidently is a broad streak of humor stowed away in the cranium of Mark R. Lamb, manager in South America for the Allis-Chalmers Co., with headquarters at Santiago. He has been evolving a chart the object of which is to enable men in the profession and others to quickly and unerringly determine a "rating" for mining engineers. He gave his snap away by submitting the drawing and "solution key" to the Engineering and Mining Journal, from which Mines and Methods reproduces it. That "many a true word is spoken in jest" finds full exemplification in the story. Read it.

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The war of words over the present copper market is less sanguinary and more amusing than some others, says the "By the Way" man in Engineering & Mining Journal. The Boston News Bureau quotes a prominent producer, who has been underbid on recent business, as saying: "We can hold out until Christmas at 17¾, and I believe that this is the sentiment of all the leading producing interests." The situation has been stated in the following words in the Wall Street Journal: "The guerillas of the copper market, that is to say, the small and second-hand dealers, are offering electrolytic, delivered, 30 days, as low as 17⅜c. a lb., which naturally renders the 17¾c. peg price of the large interests a nominal quotation"; to which the Journal of Commerce adds in reply the question: "What about the highwaymen who hold up consumers for the benefit of copper-security speculators?"

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The late Malcomb L. McDonald, who will be remembered as a most prominent figure among engineers during the Goldfield boom days, once remarked, while in Salt Lake, that the most profitable investment that he had made while interesting capital in the Nevada camps, was in the purchase of a big automobile. He declared it had a greater influence in parting investors from their money than had anything which the camps had to offer in the way of a mineral showing. Wonder if the same idea is not paramount in the minds of "mining magnate engineers" of these days who blow themselves for private cars and steam yatchs "for business and pleasure purposes?"

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In this number is the first of a series of articles by Al. H. Martin, of Redding, California, descriptive of the methods and practices employed in gold gravel mining. In this first article a brief but comprehensive outline of the devices and schemes employed from the earliest days to recover gold from placer sands and gravels by "dry washing" is given. All branches of the industry, including hydraulic, elevator, pump-dredge and other methods of winning gold not mined in the regular way from veins and deep deposits, will be covered in the articles to come and, as Mr. Martin writes to entertain as well as instruct, his contributions on the subject will be read alike with equal interest by the engineer, operator, investor, miner and layman.

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A good deal has been recently heard about "holes in the air" in connection with sudden collapses of flying machines. Prof. W. J. Humphreys of the Washington Weather Bureau, classifies the eight different types of atmospheric disturbances as follows: A vertical group, including aerial fountains, aerial cataracts, aerial cascades, and aerial breakers, and a horizontal group, including wind layers, wind billows, and aerial torrents; in addition, wind eddies fall under both groups. Holes in the sense of vacuous regions do not exist.

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The Herald-Republican of the 21st quotes "a Salt Lake engineer" who had just returned from a trip to Bingham, in part as follows: "Judging from my personal observations and what I could learn, I believe the Utah Copper company is in better shape than any of the other properties in the district affected by the recent strike. It appears to be employing fully if not more than half its usual force, and the production must be considerably better than half its regular output, which was 18,000 to 20,000 tons daily. A dozen or more of the twenty big steam shovels are busy, and a large tonnage is being sent to the Magna mill. There the vast capacity for ore easily takes care of the half ration it is receiving. Where in normal times you could see twenty-five to fifty loaded cars standing in the yards, yesterday I didn't see one. * * * But to tell you the truth, the way men have left Bingham by the hundreds, and the greatly reduced outputs of the various mines and the difficulty to get laborers, the camp really has a gone-to-hell appearance."

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The commonest form of occurence of molybdenum is in the form of the sulphide, molybdenite, which resembles graphite very strongly. It may be distinguished from it, however, by its weight and by the fact that on glazed paper or porcelain it gives an olive-green streak, while graphite shows black. Moistened with sulphuric acid and heated vigorously, and then allowed to cool, molybdenite gives a beautiful blue color when one blows gently upon it with the breath.

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Oil for use in a blow-pipe lamp should be rich in carbon. Refined rapeseed oil is used for the purpose, as is olive oil, lard oil, and mixtures of turpentine and alcohol. The disadvantage of these is that they are not always easy to obtain and are objectionable in case the oil is spilled. For this reason, an ordinary small alcohol lamp is commonly employed, but it is impossible to secure a reducing flame, but the ordinary 'short six' is too small to give a large enough flame. In some places large candles of about 2 in. diam. can be procured or, with an empty condensed-milk can to serve as a mold, and employing the smallest size of flat lamp-wick, they can be made with very little trouble by remelting ordinary candles.

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Scale in boilers one-sixteenth of an inch thick means a loss of 25% in efficiency.

EXTRACTING GOLD FROM GRAVEL DEPOSITS

By AL. H. MARTIN.

Man's first gold came from surface placers. Centuries before any attempt was made to win auriferous values from lode veins, the banks and bars of rivers and tributary streams yielded their treasures to armies of searching slaves. Labor was a secondary consideration in those days; the strong arm reached out and gathered workers at its will and practically whole nations were enslaved and set at work in the mines and fields. The fabulous wealth of Ophir and other wonderfully rich districts were derived from the bountiful deposits of gravel that invited where the wandering water courses had deposited their golden memoirs. That many of these placers yielded enormous wealth is evidenced by the plentitude of gold displayed by the leading nations and private individuals. In some states gold became so common that the less easily-obtained silver was the ruling metal Historical records of the wealth of ancient Greek and Roman families proves many of these private treasuries compared favorably with the great private fortunes of modern times. All of these authentical facts combine to prove that gold must have been produced in immense quantities from the surface deposits of ancient Africa and Asia.

The presence of water for washing gravel and aiding in detection of the elusive gold particles, has always been recognized as a highly desirable factor. But it has often developed that some of the richest gravel occurs in districts remote from the appreciated element. Consequently, air has often taken the place of water, with the blast coming from the strong lungs of the worker in numerous instances. At times the uncertain wind has been impressed to aid in the work. In some of the provinces of China and other Asiatic regions the primitive practice still exists. The gravel is brought on the backs of the workers to a selected spot. Women are generally the beasts of burden, and the material is loaded into bags for the short trips to treating point. The gravel, dumped in conical heaps, is sifted by a man and woman tossing handfuls of the material to the top, which enables the wind to blow away the fine sand while the coarser sand and gravel gradually works to the bottom of the heap. The coarser pebbles are brushed away from the heap and the whole mass gradually reduced to coarse sand and fine pebbles. The miner gathers this in a wooden bowl and holding it high above his head pours the material slowly onto a cloth stretched on the ground. The sand and other particles are naturally blown off by the wind, or should the kindness of heaven fail, the worker emits mighty blasts from practiced lungs. With air-blasts from his lungs the miner blows away the sand and pebbles from the cloth, starting on the edges and working slowly inward. His co-workers, men and women and children, gather around the cloth, and lying on their stomachs watch with eagle eyes for the yellow glint that betrays the gold particle. Each flake of the precious metal is promptly detected, and great is the rejoicing if a few particles of yellow are the reward for a day's work. The plentitude of labor in central Asia permits the working of gravel containing minute traces of gold, that would be absolutely unworkable in other climes. For centuries this crude method has prevailed, and the result has been the development of the Chinese miner into the greatest gravel worker of the world.

ELEMENTARY AMERICAN PRACTICE.

In elementary American practice, the batea, or wooden pan, was extensively used in dry-washing. By means of skillful agitation with the pan, the mass of gravel is gradually worked toward the centre, while the miner blows away the lighter particles. By clever manipulation of the pan and force of air-blasts the waste material is gradually separated from the gold particles, and the latter easily recovered. This method is one of the oldest in existence, and at times has been employed with excellent results, but, of course, is obsolete in this progressive age

The first great step toward the modern dry-washing machine was introduced in Mexico in 1850, as near as historians have been able to determine. Hungarian miners are credited with the device, which consists principally of a tray, cross-riffles, and canvas bellows. The tray is usually three feet long by eighteen inches wide, with a muslin bottom. The riffles, generally numbering five, are mounted on a frame with an approximate inclination of 15 deg. Beneath this frame the bellows are placed. The gravel is fed into a hopper commanding the tray and moves slowly down the riffles. The bellows drives an intermittent blast of air through the muslin bottom of tray, and the lighter material is forced over the sides and swept away. The gravel flowing down the incline deposits the heavy gravity gold behind the riffles, while the coarse material and fine sand passes over the riffles and out of the machine by the lower section. The slope of the machine may be varied at will by slipping blocks under the rear legs, and when conditions justify, an inclination of 20 to 25 deg. is maintained. The bellows is operated by a wheel turned by one of the miners, and the force of the blast regulated to handle the material to best advantage. The concentrates deposited in the tray are transferred to a batea, where the gold is further cleaned and recovered.

In recent years the size of tray and power of machine have been largely increased, and many of the devices now employed have trays with dimensions of 30 by 60 inches. Two men are employed in operating such a machine, one working the wheel and regulating the air-blast, the other feeding gravel into the hopper and watching the riffles to see the machine is not loaded beyond a safe capacity. Before the gravel is fed into the hopper it is spread out in the sun to dry, and boulders and rocks removed by hand.

In the sunny regions of Mexico, Arizona, southern California and similar sections this practice is easily effective. The machine is undoubtedly efficient in the hands of skilful workmen, but some fine gold is lost with the wasted sands. However, the loss from this source is stated to be small, and the machine is employed more extensively than any dry-washing contrivance on the market. The small cost, and the simplicity of operation, are pronounced factors in its favor.

VARIOUS TYPES OF MACHINES.

The Steele-Sutton-Steele air-jig closely resembles the Hungarian dry washer, with the exception that the stationary tray is displaced by a revolving table or belt, three feet in diameter. This has a muslin screen and riffles about eight

inches apart. As the intermittent blast from the bellows drives the fine sand over top of table, the belt raises the concentrates to the edge of the machine and deposits it in a gold-saving box at the rear. It is stated that this type of machine has demonstrated its ability to recover an extremely high percentage of values in the Sonora, Mexico, fields, but has a tendency to get out of adjustment, forcing frequent stops for a realignment of working parts.

The next important advance in the dry-washer was the substitution of a fan for the long-used bellows. This permits the employment of a constant blast of air, and increases the working capacity of the machine. Most of the latest type of dry-washers manufactured employ the fan, and results are stated to be satisfactory. In some of the machines lately devised, wire gauze and perforated screens are used in the place of the old muslin bottoms. The muslin naturally wears out rapidly, and the use of metal screens materially prolongs the life of this portion of the contrivance.

In the Curtis machine, the tray is in the form of a trough covered with plate nearly an inch thick. This plate is pierced with semi-circular apertures, arranged in cross-sections. Each perforation has an approximate diameter of an inch, and are partly closed by a strip of wire gauze located beneath. This permits the free circulation of the blast from the fan through the material, but effectively prevents the loss of concentrates. The machine is given a laternal agitation by a cam, and the gold settles into the apertures, which takes the place of the ordinary riffle. The Jardine type changes the blast of the fan from constant to intermittent by employing a rotary valve, on the principle that an intermittent blast permits the gold to settle more readily than a constant current of air. In other types of machines, the washer closely resembles the concentrators employed in quartz mills, with fans delivering air for the agitation of materials.

The Lansdale machine, is a combination concentrator and amalgamator, embodying some new principles of interest. In place of the old-time tray of the Hungarian dry-washing machine, is a shaking pan formed like an inverted cone, with a shallow well in the centre, and surmounted by a revolving disc, which forms ths cover of pan. On the underside of this disc are attached several concentrator prongs so arranged that in operation the coarse gravel is expelled from the pan, while the finer portion is retained and agitated until the gold settles into bottom of pan. The shaking motion of the pan carries the gold to the central well where it is caught by mercury previously deposited. The gravel is admitted to the pan through a conical hopper, fed either by hand or a mechanical elevator. A recessed ring containing metal balls is placed around the edge of the pan, and on this the disc revolves. Between the outer edge of pan and the ring is a space about an inch wide through which the tailings are discharged into a funnel-shaped hopper, which carries the waste away from the machine. It is claimed that all fine gold is recovered by this device, and the amalgam can be either retorted in the usual manner, or strained through chamois leather, depending on the condition of the gold. This machine is rather a concentrator than a dry-washer in design, but is said to be most efficient wherever tested. It is a radical departure from the original dry-washer, but retains some of the old-time principles. Mechanical means, instead of the air-blast, are depended on for separation of waste gravel from the gold-bearing material.

The various types of machines herein described, illustrate the numerous attempts made to devise a satisfactory method for the recovery of gold from dry placers, and inventors are constantly endeavoring to augment the efficiency of the numerous contrivances. Hundreds of varying devices have been fabricated, but few have justified their right to endure. The original Hungarian machine still claims the greatest following, its remarkable simplicity causing it to be favored over many later devices of unquestioned merit. Still, numerous machines of recent design are employed in California, Nevada, Arizona and some of the Mexican fields in preference to the more ancient type.

PROBLEMS TO BE MET.

The successful treatment of gravel by the dry-washing process is largely dependent on natural conditions. There are many factors to be considered by the engineer, and the machine is naturally forced to meet several circumstances of prime importance. Some deposits are practically impossible to mine successfully by the dry-washing method, while others present difficulties of an exceedingly complex character. The concentrator must be a machine of fair capacity, low working cost, and able to handle fine and coarse material. When the gravel is cemented, the material must first be crushed to free the gold-bearing material from barren rock, and to release the gold values.

This problem has been effectively solved by the Queener machine, familiar to most gravel miners of northern Mexico and southwestern America. The device consists of a steel trommel fitted with a shaft revolving independently and commanding a number of chain hammers. The hammers easily crush the cemented material which escapes to the gold-saving apparatus through quarter inch spaces between the steel staves of the trommel. The pebbles and cobbles are forced to the end of trommel and discharged. This machine has come into general use in the dry placer fields where cemented material occurs, and has proven remarkably effective. The crushed material is subsequently treated on dry washers and the gold readily recovered by usual means. Credit for the device is claimed by Joseph Lusignan and Mitts Queener, but the latter exploited the machine commercially and is generally considered the inventor. Its use has enabled operators to mine deposits previously considered too refractory for consideration, and has given an emphatic impetus to gravel mining in the arid districts of the great southwest.

It is imparative that gravel be dry. The average material as it comes from the mines is too moist for dry washing, and while the sun is an efficient ally of the gold miner in these sunny regions, it has been found best to dry the gravel by mechanical means. The small operator spreads the moist gravel in the sunshine to dry it, but this is impracticable when a large tonage is treated. The pulverizing of cemented gravel generates sufficient heat to largely remove any moisture prevailing, and cemented material naturally contains less water than the more porus uncemented material. The size and mesh of screens is regulated by the gold, coarse gold requiring larger mesh than that of finer structure. These are some of the questions to be solved by the engineer when arranging for installation of dry-washing devices.

FEATURES OF COLORADO RIVER WORK.

An interesting illustration of dry-washing methods is presented by some of the companies operating in Arizona, near the Colorado river, and a brief description of the process employed may be instructive and entertaining, as the methods have been fashioned along the lines of latest practical developments. In some portions of this deposit the gravel has been penetrated to depths of twenty and thirty feet to the cement bedrock, which in places proved richer than the gold-bearing gravel itself. For years mining has been conducted along restricted lines, the workers frequently packing the richer material from claims to points along the river where water was obtainable for washing. But the great proportion of the deposit could not be thus treated, and dry-washing was eventually recognized as the only practicable means for extraction of the gold. Several small machines of the Hungarian type have been tried at

various points, with pleasing results. About a year ago eastern capitalists became interested in the field, and the Yuma Consolidated Company and other corporations commenced work along progressive lines.

The gravel is gathered up by a Barnett dredger, mounted on a movable platform, with the arm and shovel collecting material in its circular swing. About three cubic yards are gathered at every revolution. The shovel dscharges onto a conveyor commanding a grizzly. The grizzly bars throw off the boulders and large stones, while the finer material drops into a Queener pulverizing machine. From this the disintegrated material is delivered to a Stebbins concentrator. This machine is composed of a table and riffles of sheet metal, and in general form and action bears a striking resemblance to a Wilfley table. The metal table is perforated with exceedingly minute slits, having quarter-inch lengths. A fan drives a constant blast of air through these apertures and the slits, so arranged as to give the air-jet an approximate inclination of 10 degrees above surface of table, causes the air-wave to move down the sloping surface with the gravel. It is claimed that material as coarse as half-inch is easily concentrated on this machine. As 95 per cent of the gold is saved by this simple process, there is no necessity of clean-ups. The black sand, platinum and other metals are separated from the waste product by the concentrator and saved, while the barren rock is received by a conveyor and delivered to the tailings ground. A 130-horse-power distillate engine furnishes power for the entire equipment. The plant has a capacity of 2,000 cubic yards of gravel per day of 24 hours. The placers are situated four miles from Quartzite, and approximately seventeen miles from the town of Ehrenburg, on the Colorado river. In many respects this plant is one of the most complete and efficient ever installed in the dry placer fields of the southwest, and results are understood to be most encouraging. It is stated that comprehensive sampling of the deposits gives average values of over 60 cents per cubic yard.

As in other forms of mining, the larger the amount of gravel, the greater is the profit per cubic yard. For this reason, a large machine can operate profitably in a district where the small washer would only yield mediocre results, all things being equal. When the extent of deposit is extremely limited, the installation of comprehensive equipment, of necessity, is often precluded. In most instances operating costs are light, and only a small crew of workmen are required to keep even the largest plants in constant commission.

WHO IS A MINING ENGINEER

By MARK R. LAMB.*

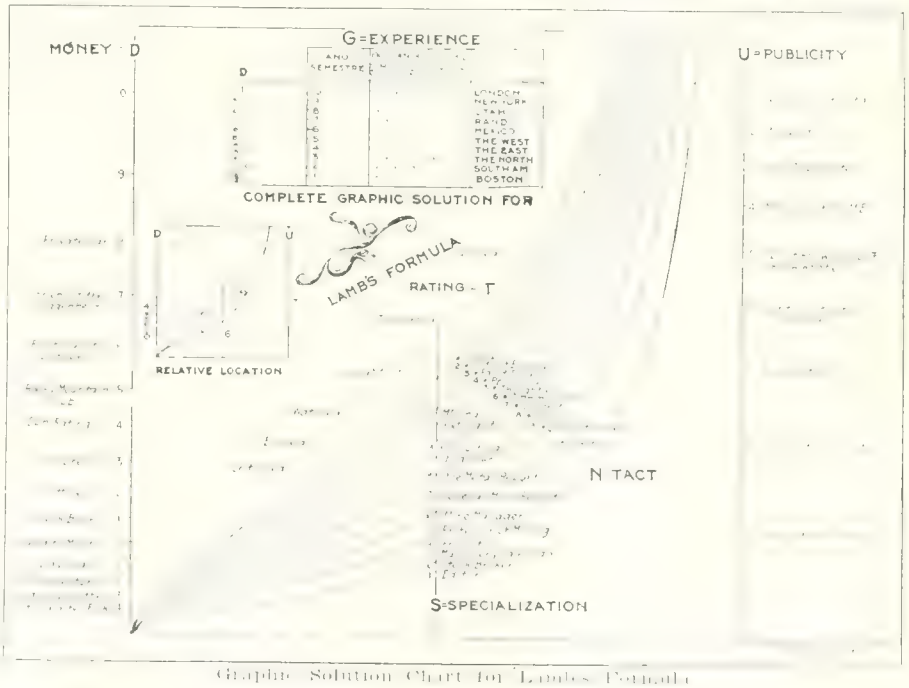
This question has been discussed exhaustively, but heretofore only as an ethical problem. I have discovered that it may be solved practically to two-decimal accuracy by the use of an easily understood diagram. Right now, before going further, it is insisted that to be entitled to consideration, any criticism of this solution or of factors or their values must be accompanied by a sworn statement that the critic has not yet determined his own Relative Location.

THE FACTORS NEEDED FOR SOLUTION.

The purpose of the chart is to furnish a rapid solution, sufficiently accurate to be well within the limits of the observed data. The chart consists essentially of three parallel scales, one for Publicity, U; one for degree of Specialization or diffusion of efforts, S; one for Money value, D; a diagonal line graduated in Professional Associates Ratlines determined by the given conditions.

A good client of mine will serve as the subject for an example. The diagram has been so arranged that, given the necessary data, the relative location of a mining engineer can be determined in ten seconds. To make the method clear, however, it will be described in some detail. My good buyer came to Chile to examine a copper mine, bought it, promoted it, equipped it and is now manager. Plainly therefore, his value on the Specialization scale is 6. As the word "native" frequently is on his lips, his Tact factor can never by any chance be greater than 5.

Project horizontally from 6 of the Specialization scale to Tact curve 5 and thence vertically to the rating diagonal. A straight-edge connecting this point with 7 on the Publicity scale (he contributes to the Journal and is writing a



Graphic Solution Chart for Lambs Formula

ing, T; and a set of curves for the various values of N, or the coefficient of friction, sometimes improperly called "luck" curves. This Tact factor N, while of course the most important, unfortunately must be assumed. It has been found best to obtain disinterested opinions from various sources and either average or integrate them.

Corresponding values for Money and for Publicity lie in a straight line through a point on the Rating diagonal where this is cut by a vertical through the intersection of the Specialization and Tact

book on "The Aborigines as Miners") gives him a rating of 2.5 on the money scale. This is only fair and handicaps him in the final test.

His geographical position during the sumed with any degree of confidence in its accuracy. Indeed, this is very variable and can vary with the climate, the dinner or the baby's health.

Space forbids enlarging upon this important factor. Each would-be mining engineer can look back over his life and locate definite periods when his value for Tact was very low and changeable. Usually—though not always—he can notice a gradual increase in value.

*Manager in South America for Allis-Chalmers Co., Santiago, Chile.

last five years, by semesters, was as follows: Beginning with the first semester of 1908, his record on the "G" table appears as a broken line through the points 2, 2, 4, 8, 9, 2, 2, and 2, making an average of 4.5 from which project to the small Money scale. The point of intersection on the Relative Position scale gives his standing as a mining engineer. It will be seen that his relative position is secure at 4, but how much better it would be with at least some experience in London—or with a high Tact value.

He is an example of man whose actual earnings would entitle him to a higher position on the Money scale, except that such earnings are not as a Mining Engineer, but rather as a commercial reward.

BABY'S COLIC AS AFFECTING RELATIVE LOCATION.

Each engineer, in determining his own location, will find that some years of study and self-examination are necessary before a value for Tact can be as

The word-values opposite the numbers on each scale are intended only as an aid to the unimaginative. Conceivably they may be changed or inter-changed, though this should be done with extreme caution. Even before this has gone to press, a noted engineer has insisted that "full-dress" and "check book" on the Money scale should be interchanged. He gives no reason, but it is perfectly plain that such a change would raise his relative position. Another engineer insists that he would travel "first class to Europe" under any circumstances. He declines to give us his factors for working out his position, but it seems certain that his experience points would be all close to the "Boston" line. Word-values may be interlined between those given on the various scales, depending upon the ideas of the engineer.

It will be noted that while the value of Money influences and in fact will usually predominate in determining the relative location of the engineer, experience and consequently knowledge has progress is stopped quicker and oftener by a low value of the coefficient of Tact than by technical shortcomings.

PUBLICITY BY TECHNICAL CONTRIBUTIONS.

Values for Specialization and Publicity can be determined easily. The first is not easily changed and depends more upon outside influences than any of the others. Publicity can be changed only by the expenditure of effort continuously, though it can be gained out of office hours, on the train, during holidays and Sunday mornings by a judicious and continuous recording of experience for the technical press.

The chart furnishes a means of determining any one of the four factors, the other three being known. This will be very useful when it is desired to find the Tact coefficient of a man, for example, who is to be employed by a stupid board of directors or in a country where the feeling against his nation is strong. The determination of this factor from testimonials or even from preliminary interviews is misleading. This is because, however variable its value, Tact is always under the absolute control of the engineer whenever he sees fit to exercise control. His prospective employer wishes to know its average value.

The range of values on the several scales covers all but the most extraordinary conditions. The graduations on the Money scale range from "private car" to "visiting wife's folks." This will include 99.9 per cent. of the readers of the Journal.

The Specialization scale provides for any possible condition, as is proven by the terms describing the two extremes. It is perhaps well to forestall possible impulsive and unthoughtout criticism of this scale by explaining that while a diversified or dispersed experience increases a man's value as a manager or editor, it does not per se increase his value as a mining engineer.

The Publicity scale ranges from utter obscurity as described by the words "secretive of data" to "featured in the Saturday Evening Post." These are certainly the limits of terrestrial publicity. Two years have been spent by the writer in the study of the values for the Publicity scale. Therefore, though this factor may seem to have been given undue importance, it should be accepted with entire confidence.

It is understood, of course, that only desirable publicity is available as a factor. In one of the early attempts to arrange the diagram, the publicity scale included minus quantities. The minus portion of this scale is useless, however, since no degree of Specialization could raise an engineer's value above zero, if his Publicity rating were below zero. It is hardly necessary to say that a high value for Tact is incompatible with a low Publicity.

There is no royal road to desirable publicity. Neither can it be purchased. An engineer I know has a standing offer with the editors to buy all the desirable publicity they can furnish. He also has a reward standing for a practical, effective scheme for professional advertising. There is another point to be taken into consideration in choosing a value for the Publicity factor. An engineer may today enjoy a high degree of desirable publicity and tomorrow, through having detached more than his dentist has equipped him for, suffer with an equally large factor of publicity of opposite sign. The desired value in such case is obtained simply by adding the plus and minus quantities.

TACT THE IMPORTANT FACTOR.

The Tact curves cover all the values obtainable from such noted authorities as Socrates, Marcus Aurelius, Aesop, Solomon, Lord Chesterfield, Uncle Remus and Uncle Charley. The coefficient for Tact is, of course, the most influential. Except for the effect of the title of this article upon the value of my own Publicity factor, it would have been called the solution of the Tact formula.

The Money scale, or the man's monetary values as a mining engineer (upon which the results are usually sought) with reasonable care in reading will give results to within two or three units in the second significant figure, an accuracy well within that of the original data. With Specialization and Publicity factors unvarying, an engineer will find his Money value shift frequently from "full dress" to "check book." "Office" is the critical point with many engineers. It is a point reached several times before it is passed permanently. This fluctuation is caused by variations in the value for Tact.

The study upon which this solution is based has been laborious, extending over many years and involving the painstaking accumulation and correlation of data. It is based upon strictly scientific and accepted theorems and I trust that my own life line will not be thought to have influenced the final diagram.

WHAT NOT TO SAY AND WHEN.

Many lessons can be gathered from a few searching and candid analyses of the qualifications of one's friends. For example, if my client above mentioned had a pubicity rating of only 4 or 3 his Money value would be very low. Even with a protracted London experience, he could not attain a good relative location as a mining engineer. To be sure, he could raise his Tact factor, but he will not—he is too old. A man entitled to Tact curve 7 or 8 will rarely find use for the words 'Englishman," "American" or "native" in ordinary conversation. If he must know your nationality he will say, "What is your native city?" rather than "Do you speak English?"

Much (Allis-Chalmers Co's.) time has beent spent in preparing this. If it has been the means of calling your attention to the low average value of your Tact coefficient, your employer's sighs of relief will amply reward me. In order to obtain the best results from the use of the diagram it should be used frequently and should be kept handy. This advice is particularly for the younger men. They can learn and change, whereas the old men are bunkered.

FIRES IN METAL MINES; REMEDIAL SUGGESTIONS

By GEORGE J. YOUNG.*

The recurrence of mine fires in Nevada during the past decade is not only a matter of interest, but also one of considerable concern to engineers and mine managers. The more important fires may be enumerated as follows:

Forman Shaft fire, Gold Hill, April 21, 1903; shaft house, machinery, and shaft destroyed; loss estimated at $50,000; cause unknown.

Union Shaft fire, Virginia City, July 14, 1904; shaft house, machinery, and shaft in part destroyed; loss estimated at $100 000; cause of fire stated as the careless throwing of a match in the rope-house.

Sutro Tunnel fire, Virginia City, Jan. 27, 1909; 700 feet of tunnel-timbering destroyed, and direct damage of $10,000; cause "probably electric wires."

Belcher Shaft fire, Gold Hill, August 9, 1910; shaft-house destroyed, machinery ruined, and upper part of shaft damaged; damage, $25,000; no cause given.

Belmont Mine fire, Kimberly, August 23, 1911; fire originated in shaft-station from unknown cause; 7 men killed, and $34,521 damaged caused.

(Note 1.—On June 11, 1912, some time after the present paper was written, a fire broke out in the pump-room on the 2475 station of the Ward shaft, Virginia City. This fire was caused by the short-circuiting and exploding of the starting switch on No. 5 pump. The oil in the switch was scattered about and set fire to the timbers and lagging of the pump room. The pump man in charge notified the surface, and the electric current was shut off. A hose was then turned on the fire but the dense smoke drove the attendant out. Inspection by the electrician and the shaft foreman, equipped with oxygen helmets, soon after, showed no flames or excessive heat, but the continued expulsion of smoke indicated that some fire was present. The pump chamber was then ordered flooded. No estimate of the damage was published and no fatalities occurred.)

It is not the purpose of the present paper to discuss the above examples, but rather to use certain features of them to formulate general plans which might be of use in fire prevention and fire fighting.

In the above list fires are noteworthy in that they originated in wooden shaft houses and communicated with workings underground, resulting in considerable damage. The risk taken by closing in the mouth of a shaft with wooden buildings has long been recognized, and most of the western mines have eliminated the shaft house. In Virginia City, on account of the severe winters, the shaft house has been retained, but, following the lesson given by these three fires, and the passage of a mining regulation governing this feature of mine construction, active steps have been taken to remove the risk. In almost every case where the shaft is used as a working shaft wooden buildings about the shaft mouth have been removed.

Mine fires may be considered in two groups: those which occur in the surface plant and those which occur in the underground workings. Fires in mine surface plants do not, as a rule, result in loss of life, and if proper fire fighting facilities are provided, the fire may be extinguished with but moderate loss. In Nevada considerable progress in the use of fire proof construction has taken place in recent years. The following steel and semi-fire-proof constructions may be noted: Goldfield Consolidated mill, Goldfield; New Belmont mill, Tonopah; Nevada Consolidated concentrating mill, McGill; Nevada Reduction Works mill, Dayton; Nevada Hills mill, Fairview; Pittsburgh Silver Peak, Blair.

Steel head-frames: Montana Tonopah, Tonopah; Tonopah of Nevada, Tonopah; Union shaft, Virginia City; Star Pointer shaft, Ely; Merger mines shaft, Goldfield; Giroux mine, Kimberly.

The protection of the surface plant from fire is recognized as a necessity, and most mining companies, where an extensive plant has been installed, provide facilities of some sort for fire fighting. In the design of a surface plant the question of fire risk should receive considerable attention. The segregation of different parts of the plant, the separation of each unit by a sufficient distance to prevent the spread of a fire from one unit to another, and, finally, the use of materials which are either fire proof or of a slow burning nature, are the main points which deserve consideration at the start. While it is true that the use of expensive materials and equipment is not warranted in the early stage of a mine's development, it is often the case that after a mine has reached the producing stage the same types and materials of construction are used, and a surface plant grows until it involves an amount of combustible material that in itself is a risk of some magnitude. The inevitable happens, a fire gets beyond control, and the destruction of the plant follows; this occurs in spite of what were deemed adequate fire fighting facilities.

That a more general use of fire proof and semi-fire proof materials and construction in western mines is merited goes without saying. That there is progress in this direction no one familiar with the more recent camps of the west can deny. It may not be out of place here to review the different types of building construction used for surface plants. They may be enumerated:

1. Timber frame with board siding.
2. Timber frame with corrugated iron siding and roof.
3. Steel frame with curtain wall construction in which brick, ferroinclave, and cement plaster or reinforced concrete is used.
4. Reinforced concrete.
5. Brick walls, steel frame, and corrugated iron roofing.

In Nevada the first two methods of construction are common in the case of the most mines and prospects. Of these, the second method is preferable on account of reducing the amount of combustible material. By whitewashing the timber work both ignition and the spread of a fire may be retarted. The third method of construction is in use where large plants, more or less permanent in their nature, are erected. Examples have been cited above. The fourth method is quite common in coal mine surface plants in Westphalia, Germany, but is not often met with in the Western States of America. It merits consideration by the mining engineers of the United States. The use of reinforced concrete in uncommon, but some examples are to be recorded in Nevada. The Midway mill, erected in the early days of Tonopah, was constructed with steel frame and corrugated iron siding, and contained a reinforced concrete ore bin. In the Belmont mill and the Goldfied Consolidated mill, reinforced con-

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Trans. Am. In. of Mining Engineers, October, 1912.

crete has been used. In Nevada, brick construction, for obvious reasons, is not used for mine plants, but in the case of electrical installations for power plant and sub-stations this method of construction is common.

The critical parts of a mine surface plant are: the blacksmith shop, boiler and power plant, change quarters, wood shop, oil-storage, rope house, and the structures about the shaft mouth. With order, cleanliness, and a proper segregation of buildings, there is little chance for a fire, and yet carelessness on the part of any individual may be the cause of starting a fire, and consequently protection must be afforded by fire plugs and hose reels attached to the water system. Usually the mine plant is compactly arranged, and several plugs and hose reels may serve all purposes. Small fire extinguishers in each building are also considered necessary.

Underground mine fires are serious, as in almost every case there is danger that fatalities may result, and the difficulty and danger of fighting such fires is great. In heavily timbered mines where there is little or no water, the possibility of a small fire spreading throughout a mine is always present. Fortunately, dry mines usually do not have large areas of heavy ground, and heavily timbered mines are often wet mines.

CAUSES OF MINE FIRES.

The causes of fires in metalliferous mines are:

The presence of combustible materials, such as timber, oils, waste.

Carlessness with candles, lamps, and smoking.

Blasting; remnants of smoldering fuse.

Overheated bearings in machinery.

Short circuiting and overheating of electric wires.

Spontaneous combustion.

Rapid progress has been made in the development of methods of mining involving a small proportion of timber, as compared with that required by the "square set" system, are in use. Even though we may largely eliminate timbered stopes or, by filling, practically eliminate the fire risk from them, we still have the timbered drifts, stations, shafts, pump stations, and winzes. We could almost completely eliminate the fire risk from these by the use of steel and masonry, but this is practicable only in a few cases, and the mines of the west will undoubtedly utilize timber for many years to come. Underground, a relatively large amount of combustible material must be contended with. The critical places are the shaft mouth, the shaft, the stations, the drifts, and the winzes. The critical condition is where the timber is dry and comparatively little water occurs. Where water is encountered the fire risk is lessened. Systematic elimination of combustible material should be the first thought of the engineer. The proper protection from fire where combustible material must be used is the next consideration.

Carelessness with candles may be eliminated by the introduction of electric lighting, and this method of lighting is common in western mines of any size. Where candles are used, proper receptacles at stations and in stopes should be provided and their use insisted upon. The use of these will go a long way towards eliminating this cause. The setting of lighted candles upon timbers should be prohibited, and the removal of all candles from working places when miners are leaving should be required. Lamps should be sparingly used, and where possible these should be filled and trimmed outside of the mine. Oil, and particularly oil required in illumination, should not be stored in the mine. Where oil lamps are used by the miners, some form of solid illuminant should be used. Smoking can be controlled by mine regulations, and in the heavily timbered mine, or in and about a wooden surface plant, it should be prohibited. Where possible, the development of a stable, steady working crew of men is an important factor in preventing accidents of any kind. Good foremanship is essential to this end.

Blasting as a cause of mine fires is, no doubt, of minor importance. I know of no authentic case where the flame of a blast has been responsible for setting timbers on fire. In the case of the Homestake fire a piece of smoldering fuse has been given as the cause. However this may be, it is necessary to carefully inspect timbered stopes after blasting. A fire originating from any cause during the interim between blasting and the arrival of the next shift may thus be discovered before it has gained any considerable headway.

Overheated bearings of machinery are an infrequent cause of fire. Underground ventilating and pumping machinery are the only forms of machinery which would be likely to cause trouble of this nature. Ring oil bearings on motors and fans have, to a considerable extent, removed this source of danger, but frequent inspection of machinery should be made. Where fans are in use an inspection should be made at least twice a shift by the shift boss. Ring oil bearings should be frequently examined and kept filled, and at intervals the oil should be completely removed, and the bearings thoroughly cleaned. Machinery oil should be kept underground in quantities only sufficient for several shifts' use. Machinery, where possible, should be placed in untimbered chambers or, where support of some kind is necessary, masonry, steel, or some fire proof material should be used. At Virginia City the pumping rooms are heavily timbered and in themselves contain sufficient timber to sustain a considerable fire. The practice is to whitewash these timbers, and to keep such rooms thoroughly clean. While this reduces the fire risk, still the presence of so much combustible material, and some of it of an oil soaked nature, must be considered as a risk, and precautions should be taken to minimize it. (See note 1.) Such chambers can be readily provided with hose plugs and reels. Where machinery of any size is in operation, the presence of attendants is usual, and is an additional safeguard. Oily waste and waste of any kind used in and about underground machinery should have metal containers provided.

Electric wires and apparatus may have been the cause of some fires, but where their installation has been carefuly looked after, and they are in the hands of experienced men, it is seldom that a fire can be directly traced to their use. (See note 1.) The proper making of connections, the use of fuses, and automatic circuit breakers on all apparatus will prevent excessive loads coming upon lines, electric motors, and transformers. At Virginia City transformers are used at several places underground. These are placed in timbered stations, but this practice is open to question. Transformers should be placed in chambers free from timbers, and only material of a fire proof nature should be permitted in the vicinity. In surface electrical work transformers are placed in fire proof buildings, and out of contact with wood work. Where transformers are in use underground, and in the vicinity of combustible material, buckets of sand should be placed where they can be used in extinguishing a fire.*

Spontaneous combustion is an infrequent occurrence, for the reason that underground conditions are seldom of a nature that would lead to this cause. Oily waste might, under extreme conditions, develop sufficient heat to ignite combustible material in its neighborhood, but it is seldom that this is present. Fires in mines containing heavily sulphureted ores are claimed by some writers to be due to the heat produced by great pressure. While this cause is not of great importance, a careful mine manager will not overlook it.

FIRE PREVENTION.

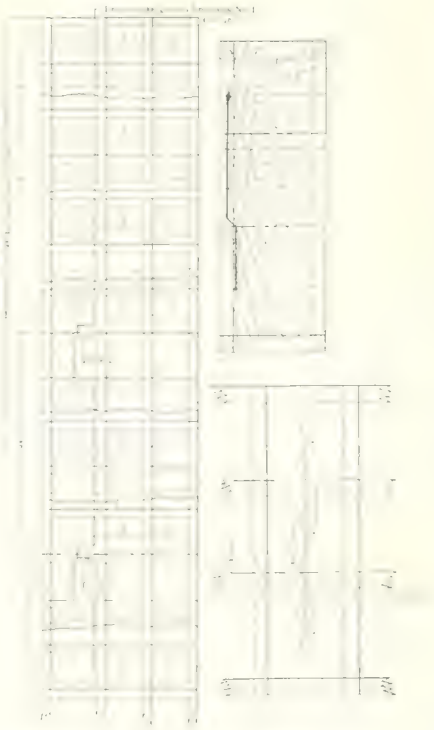
The first line of defense in the prevention of fire is a proper set of mine

*The Electrical Safety of Mine Electrical Installations, Technical Paper No 19, U. S. Bureau of Mines (1912).

regulations covering the use of candles, lamps, oils, and other combustibles used underground; the second is the enforcement of these regulations. Without discipline mine regulations are of little avail. The third line of defense is the practice of a fire drill at frequent intervals. This practice should include drill in the use of fire fighting apparatus, the training of a suitable fire fighting squad, and the accustoming of the men to answer an emergency fire call, so that a possible panic among the men on the alarm of fire may be avoided. The drill should be segregated into the drill of the fire fighting squad at least once a month, and the drill of the whole mine force in answering a fire call at least once in three months. The fourth line of defense is the use of watchmen, whose business it should be to inspect the mine workings after a shift has departed or at frequent intervals when the mine is shut down. These men serve to check up careless miners and prevent a small fire from spreading.

Facilities for fighting incipient fires should be provided, and placed at readily accessible points in the vicinity of the places where there is any considerable amount of combustible material. These places would be at shaft stations, the sill floors of timbered stopes, timbered winzes, and shaft collars. Fire extinguishers of a simple type would be the means provided. Water pipe lines should be laid to large timbered stopes, and hose connections provided. Hose reels should be placed at the critical points. The whole system should be standardized so that hose, couplings, etc., could be transferred, and used in any part of the mine. At the surface a reserve supply of hose should be provided. A monthly inspection of fire fighting appliances should be provided for.

Steel fire doors, or wooden doors protected by tin sheets, set in concrete bulkheads, should be provided in crosscuts and drifts at such points as would enable the spread of a fire starting in a stope to be checked. These would only be used in the event of a considerable fire. Such doors must be constructed so as to admit of opening from either side. In important tunnels of any great length and where timber is used several fire doors might well be placed so as to divide the length into sections. In lieu of fire doors a length of 100 ft. of the tunnel could be supported by masonry instead of timber, and this would localize a fire. In tunnel fires fire-doors cannot always be reached, and the conditions may be such that temporary bulkheads cannot be constructed. In such cases the masonry zone might prevent the fire from spreading through the entire length of the tunnel. In railroad tunnel work, where, from financial conditions, timber must be used instead of masonry, masonry zones might well be used. The recent fire in the Chilcot tunnel of the Western Pacific railroad is a case in point. A main working shaft in a mine would admit of fire localization in the same way. In place of masonry, steel tunnel sets or shaft sets could be used. While perhaps general rules for the placing of fire stops and doors could be formulated, the conditions at each mine would have to be studied and the locations of these safeguards determined in such manner as to best meet those conditions.



Automatic Sprinkler Installation for Mine Shaft.

O. F. Heizer has informed me that at the Seven Troughs Coalition mine, Seven Troughs, Nev., hinged wooden doors, protected by 3-16-in. steel sheets, are placed at the second set below the collar of the incline shaft (75° incline). These doors are held by tickers controlled by a lever. Slots are cut so that interference with the hoisting cable is avoided. Ten sacks of sand are stored close by the shaft. In the event of a fire on the surface the surface men have instructions to throw the doors and place the sand over them. He informs me that this device worked very well on one occasion when a fire took place in the surface plant. He also informs me that at the Nevada Hills mine, Fairview, two steel sheets are arranged at the mouth of the shaft so that they may be slid over the opening of the compartment by throwing a lever. No special rollers are used, the sheets simply sliding on angle irons.

To one familiar with conditions in western mines, it is a matter of surprise that advantage has not been taken of the automatic sprinkler, which is in use for the protection of warehouses, factories, public buildings, and the like. I know of no instances where this system is used underground, and only in a few instances, notably in Montana, have they been used in metallurgical plants. The system as applied to buildings consists of a net work of pipe-lines supplied by a pressure tank. The pipes are so distributed as to admit of a sprinkler-head being placed in the center of each 10-foot square. The sprinkler-heads are placed close to the ceiling. Each head is provided with an opening which is closed by a non-corrosive button. The button is held in place by a two-piece metal strip. The pieces of the strip are held in place by a soft solder which has a metling point sufficiently low to be speedily reached by any fire in the vicinity. With the melting of the solder the pieces fall apart, the water pressure forces the button out and the water spurts out against a a spreader which throws the water spray over a considerable area. A melting point of 155° F. is used in the well known Grinnell automatic sprinkler. The complete installation of an automatic sprinkler system in a mine, while not necessarily impracticable, would in most cases be unnecessary. As has been mentioned, the critical places are the shafts and shaft stations where the timbers are dry. Shaft and stations might well be protected by such a system. Timbered pump or machinery stations, on account of the value of their contents and their importance to the mine, could also be protected in this way.

The installation of an automatic sprinkler system in a shaft is represented in Fig 1. Two main points in the design of such a system need consideration: one is the question of water pressure; the other is the use of protective coating upon the pipe so that scale and rust cannot form and clog the sprinkler heads. In a deep shaft it is doubtful whether a continuous pipe line could be employed without the use of extra heavy pipe and fittings. By placing pressure tanks at intervals of from 300 to 500 feet; ordinary or "extra strong" pipe and fittings could be used. The intermediate tanks could be supplied from the pipe-line above by means of valves operated by float. The use of galvanized pipe and fittings would eliminate ordinary troubles of corrosion.

In each compartment of the shaft, at intervals, sprinkler heads, point downward, would be placed. In order to be

out of the way these would be placed back against the lagging, but this position would not prevent their effective operation. A three compartment shaft would be protected by making the intervals between sets of sprinklers 50 feet.

The cost of such a system is nominal compared to the amount of damage a shaft fire might cause. I have estimated the cost of pipes, sprinklers, and pressure tanks (every 300 feet) for a shaft 1,000 feet deep to approximate $500, or $0.50 per foot. In Fig. 1 a 2-in. pipe is assumed as sufficient. In the cost of the system should be included a fire tank on the surface. Shaft stations would be protected by extensions of the pipe system along the center line of the station and the spacing of sprinklers every 10 feet.

The advantage of such a system is its automatic operation. A fire arising in an obscure portion of the shaft would be taken care of and extinguished before it could spread. The shaft, the main exit of a mine, could thus be always protected and maintained in a workable condition. The possibility of saving life in the case of a fire would be greatly enhanced if shafts could without question be kept open.

By extending the sprinkler system along each drift for 50 or 100 feet, a fire could be prevented from spreading to the shaft.

An automatic system to be satisfactory should be inspected at frequent intervals and such a system, carefully installed, would not require an overall inspection more than once in three months

A telephone system is an indispensable part of the equipment of a large mine. Not only is it necessary to install telephones at stations, but important winzes and stopes also should be provided with this appliance. The prompt warning of the men may be the means of preventing loss of life. This could be done by telephone or by the use of flash signals where incandescent lamps are used. In Virginia City an "all out of the mine" signal is in use, and the electric lamps by a given number of flashes convey this signal.

Fire fighting helmets are now considered necessary at all large mines, and the training of men in their use should be a part of the fire drill. Oxygen helmets also should be provided for possible use in rescue work as well as for the attack of smoldering fires which would produce such an amount of smoke as to prevent near approach. So well has the subject of the construction and use of the oxygen helmet been discussed that further comment is unnecessary here*

All underground air lines should be provided with connections at stations, winzes, and stopes. These connections should be maintained in working order at all times. In the Belmont fire a connection on the air line at the 1100 station would have been the means of saving life. Where a water pipe line is not in use in a working shaft, connections should be made at the surface, so that the air line could be used for purposes of bringing water to a fire. It is preferable to have two lines of pipe in a shaft, one for water and one for compressed air.

FIGHTING MINE FIRES.

The first essential in fighting a mine fire is to get all of the men out of the mine. When this has been accomplished, a plan of action can be decided upon and carried out under competent direction. The usual steps may be stated as: bulkheading, with the object of localizing the fire; laying of hose and the bringing of a water supply to the scene of the fire.

The fire fighting squad necessarily works upon the incoming air side of a fire unless equipped with smoke or oxygen helmets. By carrying air lines along with hose lines, fire fighting squads have been enabled to approach close enough to a fire from the "lee side" to do effective work. It requires courage and daring on the part of the fire squad to perform work of this kind, but instances are not uncommon where stubborn fights of this kind have been made.

Where it is impossible to approach the fire close enough to fight it with water, two methods may be used: one is the bulk-heading of the fire on both sides and the closing of all winzes leading from the fire zone; the other is to seal the mine and fill the workings with a gas which will prevent combustion. In the former method the fire is left to smother out, and this may take considerable time. The availability of the oxygen helmet renders it possible to construct bulkheads where it would have been practically impossible without the use of this appliance. In fighting a fire by the second method, steam, sulphur dioxide, and carbon dioxide have been proposed as gases suitable for the purpose. Steam is the agent most used. If a supply of sulphur could be speedily obtained it might be possible to use this reagent in temporary burners arranged so as to discharge the gases into the intake air ways. Snelling has given details of the method. Carbon dioxide is difficult to generate in sufficient quantity, and its use is almost out of the question save as it is generated by the fire itself. Where it is impossible to bulkhead a fire, and steam or other agent is out of the question, the flooding of the mine is the next expedient. If it is impracticable to flood the mine, the turning of water down the shafts after sealing all openings to the mine is then in order.

The greater danger in all mine fires is the rapid filling up of the workings with smoke and poisonous gases (CO). To one who is familiar with fires this is the most striking thing. The comparatively restricted workings of a mine fill up in a very short time on account of the air currents, which, while normally moving sluggishly, under the increased temperature rapidly acquire velocity. The presence of fire doors at intervals may be the means of preventing workings from being completely flooded with irrespirable gases. If it were possible to stop all air currents in a mine by doors suitably placed, the fire and the gas would be prevented from spreading outside of a restricted zone.

As in the case of surface fires, "being prepared" is the key to the situation. Mine superintendents should carefully consider the possibilities of a fire, and make every preparation beforehand, even to laying out a method of proceedure for fires occurring in different parts of the mine. The drafting of a plan of action, the provision of apparatus and means for carrying out this plan, as well as the drilling and training of the men who are to carry the plan into execution, will go a long way towards preventing confusion, delay, and loss of control at the fire signal. The provision for marking the passages leading to shafts and exits hould be carried out in all large mines. A careful study of the ventilating currents in a mine and a consideration of the effect of a fire in changing their direction also form necessary parts of any fire fighting plan. Ventilating plans of the mine under varying conditions should be prepared, and their study made a part of the drill by the fire fighting squad. The effect of turning a stream of water down a shaft upon the air currents deserves mention. In most cases a stream of water turned down an upcast shaft has the the effect of reversing the air current. In the Giroux fire the upcast shaft which was on fire was provided with a water pipe, pierced with holes, close to the collar of the shaft. An attendant at the surface (without authorization) turned the water into this pipe, and thus reversed the direction of the air, causing the shaft to act as a down-cast. The Alpha shaft, which was the down-cast, became an upcast, and the miners escaping by this shaft were killed by the gases.

*"The Use and Care of Mine-Rescue Breathing Apparatus." Miners' Circular No. 4, U. S. Bureau of Mines (1911).

LEGAL REGULATIONS.

An examination of the mining laws of the western states indicates no general tendency to comprehensively cover the subject of mine fires. As an example, the regulations provided by the State Mine Inspector Law of Nevada may be cited. These regulations are grouped as follows:

Regulations Relating to Egress From Mines.

"Section 19. All shafts be equipped with ladders, and shafts more than [illegible] feet in depth, inclined more than 45 degrees from the horizontal, equipped with hoisting machinery, shall be divided into at least two compartments; one compartment to be divided off and set aside for a ladderway. The ladders shall be sufficiently strong for the purpose demanded, and landings shall be constructed not more than 30 feet apart, said landings to be closely covered, except an opening large enough to permit the passage of a man. A landing shall be constructed in manway at all working levels."

"Section 20. In every mine within this State, if more than 200 feet in depth, where a single shaft affords the only means of egress to persons employed underground, and the ladderway compartment is covered by a non-fireproof building, it shall be the duty of the operator of said mine to cause said ladderway to be securely bulkheaded, or a trap door placed over same at a point at least 25 feet below the collar of the shaft, and if a trap door is used, it must be kept closed, or so arranged that it can be closed from a point outside of the building by the releasing of a rope, and below this bulkhead or trap door, if the shaft is situated on a side hill, a drift shall be driven to the surface, and if the shaft containing said ladderway may be otherwise situated, this drift shall be driven on the level to a safe distance, but in no case less than 30 feet beyond the walls of the building covering the main shaft, and from such a point a raise shall be made to surface. The said raise shall be equipped with a ladderway, and it, together with the drift connecting with the main shaft, shall be kept in good repair, and shall afford an easy exit in the event of fire."

"Section 21.—Whenever the exit or outlet from a mine is not in adirect or continous course, signboards, plainly marked, showing the direction to be taken, must be placed at each departure from the continuous course."

"Section 28.—It shall be the duty of every operator to provide every tunnel or adit level, the mouth of which is covered by a house or building of any kind, with a door near the mouth of the same, that can be closed from the outside of the building by a pull yire or cable in the event of fire; inside of door a raise shall be run to conect with surface, thus affording a means of exit in the case of fire."

Regulations Relating to Structures over Shaft Mouths.

"Section 27.—It shall be unlawful for the operator of any mine within the State to erect any structure over the shaft of any mine, except head frames necessary for hoisting from said shaft or outlet, and the hatch or door necessary for closing such shaft or outlet; provided, however, it shall be lawful to erect a house of non-inflammable and fireproof material over such shaft or adit to protect the ment working at such point. In the case of existing houses covering months or shafts or adits, it shall be the duty of the superintendent of the mine to cause the immediate removal of all inflammable material stored therein; and it shall be the further duty of such superintendent to prohibit the storage of any inflammable material 30 feet from the exterior walls of any housing hereinafter built."

Regulations relating to Inflammable Materials Used Underground and on Surface.

"Section 16.—All timber removed shall, as soon as practicable, be taken from the mine, and shall not be piled up and permitted to decay underground."

"Section 22.—Use of gasoline understood as forbidden."

Regulations Relating to Fire Fighting and Control of Mine Fires.

"Section 11. At every mine in this State, employing forty or more men underground, there shall be kept on hand at all times, in good working condition, at least two smoke helmets of a design to be approved by the State Mining Inspector, and which helmets shall at all times be subject to his inspection. For every additional fifty men so employed an additional smoke helmet shall be provided."

The regulations are, at best, only fragmentary, but they indicate an effort to provide certain things that a mine operator must do. Most mine operators are willing to conform to any reasonable regulations, but until a more or less complete code is drawn up and incorporated in our State mining laws, we must expect to find them somewhat backward in taking the initiative, except in those cases where either bitter experience or broad training has stimulated operators to take the subject up in detail.

PROPOSED REGULATIONS.

With the object of inviting discussion, and of giving point to the generalizations in the foregoing, I have written the following regulations. The difficulty of providing for every emergency that may arise in a mine fire, and of meeting the miscellaneous conditions that are present in western metal mines, is apparent, and in preparing these regulations I have endeavored to maintain a conservative rather than an extreme position.

Egress from Mines—For mines deeper than 200 feet, and employing ten or more men underground, operators must observe the following:

1. Two outlets must be maintained in good condition at all times during the operation of the mine.

2. Where two or more shafts are in use, two of such shafts must be provided with ladder ways in separate compartments, and such ladder ways maintained in good condition during the operation of the mine.

3. Where ladder way shafts are inclined at a greater angle than 45°, landings closely boarded, and with openings just sufficient to allow the passage of a man, must be provided at intervals not greater than 30 feet.

4. In mines operated through three or more working shafts, where each shaft is provided with hoisting machinery, a ladder way may be provided in but one shaft.

5. Between levels at least one winze must be provided with a ladder way, and the same maintained in proper condition where the level is in use for extraction of ore, or ventilation.

6. On each level the direction to shafts and winzes, used as exits in cases of emergency, must be clearly indicated by signboards.

Mine Surface Structures—1. None but fireproof buildings are to be permitted over shaft or tunnel mouth.

2. Where shaft mouths are open, wooden head frames and bins may be permitted.

3. Non-fireproof buildings must not be placed nearer than 50 feet to any shaft mouth or tunnel entrance.

4. Mine plant buildings of non-fireproof construction must be separated from each other by a space of not less 30 feet wide.

5. In a mine surface plant where non-fireproof construction is employed, hoisting machinery, boiler plant, blacksmith and machine shop, timber framing shop, change house, and storage of supplies must be placed in separate buildings separated by a fire space not less than 30 feet wide.

Inflammable Materials on Surface and Underground.—1. Where fireproof shaft and tunnel houses are in use, timber or other inflammable material in excess of sufficient for one shift's use must not be stored in such buildings.

2. Timber yard or timber storage sheds must be placed not less than 75 feet from any mine building.

3. Lubricating oils and inflammable fluids must be stored in fireproof buildings separated by a distance of not less than 75 feet from other mine buildings.

4. Metal containers must be provided for the storage of all waste used in wiping and cleaning machinery. They are to be provided for each machinery room in the surface plant, and for each group of machines underground.

5. Lubricating and illuminating oils in excess of a 24-hr. supply must not be stored underground or in surface buildings other than the oil storage building.

6. Gasoline and substances of like nature are not to be used underground.

7. Timber in excess of a 24-hr. supply is not to be stored underground.

8. Powder drifts which are used for the temporary storage and handling of powder underground, must be cleared of all paper, empty boxes and rubbish, at least once each 24 hours.

9. Where timber is framed at one or more points in a mine, these places must be cleared of chips and rubbish, at least once each 24 hours.

Surface and Underground Regulations—1. Where mine surface structures are of non-fireproof construction a sufficient water supply must be provided for fire fighting purposes. One fire plug and hose reel must be placed not less than 25 feet from the shaft mouth, and such other fire plugs placed as, in the judg-

ment of the state mine inspector and mine superintendent, shall be sufficient to quench any ordinary fire.

2. At shaft house, in timber framing building, power plant, change room, and such other parts of the surface plant as the mine inspector may decide, at least two fire extinguishers of an approved type must be placed and maintained in proper working order. They must be placed in a conspicuous and convenient place.

3. Smoking shall be prohibited in nonfireproof surface plants.

4. Where more than a nominal number of lamps using illuminating oils are in use a separate lamp house shall be provided and all filling, cleaning, and trimming done in this building.

5. Where water pipes are not installed in shaft, connections must be provided with the surface water system so that the compressed air pipes may be used to bring water underground in the case of a fire.

6. Connections must be made with air pipes at each station, whether the same is in active use or not. These connections must be such that air can be turned into the station.

7. Where candle illumination is used underground metal sconces must be provided at all timbered stations and stopes and miners required to use same.

8. The placing of lighted candles on timbers without proper protection is prohibited.

9. Smoking is prohibited in timbered mines.

10. At all timbered stations which are in active use and where water supply and hose lines are not provided, at least two fire extinguishers of approved type shall be placed and maintained in working condition.

11. Where electric illumination or power is used underground or in surface plant, line installation and protection must be in accordance with the Electric Code of the National Board of Fire Underwriters.

12. Transformers, where used underground, must be placed in fireproof chambers and, at each bank of transformers, sandboxes must be placed and a supply of sand maintained.

13. In heavily timbered stopes fire inspection must be provided after each shift leaves and before the new shift comes on.

14. Air-tight doors shall be constructed in each level, where practicable, between upcast and downcast shafts. Such doors should be preferably of fire proof construction.

Regulations for Fire Fighting and Control of Mine Fires.—1. The mine foreman, under the direction of the mine superintendent, shall have charge of all fire fighting operations.

2. The mine foreman shall designate certain assistants to constitute a fire fighting squad, and assign duties to such assistant. The name of such assistants shall be posted at shaft mouths as the fire fighting squad.

3. The mine foreman shall conduct a general fire drill at least once each three months and at that time examine, test, and report to the superintendent the condition of all fire fighting apparatus, exits, and ladder ways. This report shall be in writing, and shall receive the signature of the state mine inspector on his next inspection visit after the fire drill.

4. In mines employing 50 men, at least two smoke helmets of an approval type shall be maintained in proper working condition at all times. For each 30 men in addition an additional smoke helmet shall be installed and maintained in working condition. The foreman shall instruct the fire fighting squad in their use.

5. In mines employing 200 or more men underground, at least two oxygen helmets shall be maintained in proper working condition. The foreman shall designate certain men for instruction and practice in the use of such helmets.

5a. In mines employing 200 or more men underground, a "pulmotor" in proper working condition must be provided. The foreman shall instruct the fire-fighting squad in its use.

6. A general signal to indicate a surface fire and one for an underground fire shall be designated.

7. Where practicable, an "all out of the mine" signal shall be designated and used in emergency. This signal must be used only by persons to be designated by the superintendent.

8. Detailed instructions to surface and underground men as to what to do in the case of fire are to be posted at shaft mouth and underground stations.

WATERS OF THE "GREAT BASIN"

The Great Basin of the United States is designated by geographers as that intermontane country lying between the Rocky Mountains and the Sierra Nevada system, covering portions of Oregon, Idaho, Utah, Nevada, Arizona, and California. It is called the Great Basin, because the rivers which rise in it do not flow to the sea, but for the most part empty into lakes, from which the water is evaporated. Among these lakes the largest is Great Salt Lake, which receives and disposes of the discharge of a number of rivers, the most important being the Bear, the Weber, and the Jordan. Others are Owens lake, which receives the flow from the Owens river basin; Walker lake, into which is discharged the water from the Walker river basin; Carson Sink, including Humboldt lake, into which flow the waters of Carson and Winnemucca rivers, which receive the discharge of Truckee river. All the lakes mentioned are located in Nevada except the Great Salt Lake, which is in Utah, the Owens lake, which is in eastern California. In the Oregon portion of the Great Basin there are such lakes as Malheur, Harney, and Warner. Lake Tahoe, which lies partly in California and partly in Nevada, is a high Sierra lake, which receives the water from the surrounding mountain peaks and discharges it through the Truckee into Pyramid and Winnemucca lakes. There are many other bodies of water in the Great Basin of more or less importance.

Practically all of the country included within the Great Basin is desert, though the aspect of some parts has been changed materially by irrigation. Much of the soil is exceedingly fertile when water is supplied to it, as was long ago demonstrated by the Mormons, who settled in that country and founded a strong and prosperous colony that has since taken a prominent part in the development of the west.

The Great Basin contains two irrigation projects of the government—the Truckee-Carson project, in Nevada, which will ultimately cover 200,000 acres, and the Strawberry Valley project, in Utah. The new municipal water supply for the city of Los Angeles is taken from the Great Basin through a long conduit, the conception and construction of which have been a noteworthy feature in recent engineering development.

Along certain edges of the basin, where it ascends to the mountain crests, like the Wasatch range in Utah and the Sierra in California there are many valuable sources of water power, some of which have been profitably developed.

In a region like the Great Basin, the economic development of which is so entirely dependent on its water resources studies of the flow of streams can not fail to be of the utmost importance. During the last 20 years or more work of this kind has been carried on by the United States Geological Survey, which has recently issued Water-Supply Paper 290, containing results of measurements of stream flow made in this basin during the year 1910. The work was done in all parts of the basin and the report contains records of flow obtained at 98 stations.

Copies of this report may be obtained on application to the Director, U. S. Geological Survey, Washington D. C.

FINK CLAIMS PERFECTION OF SMELTING FURNACE

Everybody in the western mining regions of this country will recall the efforts five or six years ago, of Edward Fink, a bright young metallurgical engineer, to prove to the world that he had evolved a smelting furnace in which he could produce blister copper at one operation; of his having constructed a testing plant at the Boston Consolidated mill and having actually turned out from his furnace bars of blister copper from the barrel-shaped receptacle into which the crude ore was fed. Naturally, mechanical difficulties were encountered, and while encouraging progress in their solution was being made, the inventor's backer became suddenly attacked with a bad case of "cold feet" and the experiments were abandoned. That investor, Edward Fink, did not despair and that he now has perfected a furnace that will mark a new era in ore reduction is told by himself in the following article, taken from a recent issue of the Mining and Scientific World.

The many improvements in the mehods of reducing ores are each year adding to the available ore supply of the world, for many complex ores are being brought within the scope of profitable treatment which heretofore were considered too lean or too complex to admit of economical reduction. Mention need only be made of the magnetic separation processes, the various flotation processes, either with or without the use of oil, the advent of the Bessemer converter in copper smelting practice, as well as the many attempts at introducing the various types of electric furnaces into zinc-smelting practice, to show that the metallurgy of the nonferrous minerals is now keeping pace with the rapid strides of the iron and steel industry.

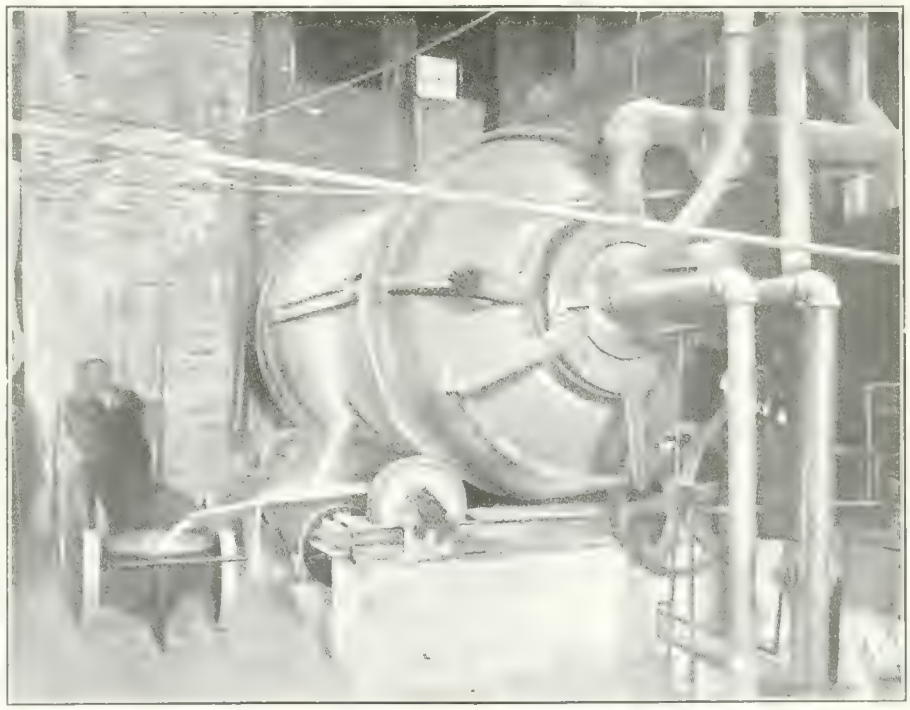
The light of scientific research has dispelled much of the mystery surrounding metallurgical operations of former generations, and a most rapid progress has resulted. Modern concentration plants have grown to prodigious size, and the furnaces used in reducing these ores and concentrate products have grown in proportion, yet in spite of these great advances in ore-dressing practice there still remains a considerable quantity of ores, which cannot be profitably treated, owing to the character of the minerals contained.

The presence of zinc has always been a detriment to the reduction of most ores, and the recent Government Bulletin No. 47, of the Bureau of Mines, by Charles Parsons, has the following reference to ores of this character:

"Besides these losses in mining and concentration of zinc ores, there are incalculable losses, which, without question, run into many millions of dollars, and undoubtedly exceed the total value of the zinc mined, in slags and waste products from other processes. Zinc has been, and in general still is, considered about the worst impurity to be found in the ores of copper and lead, for it has always given trouble in their metallurgy. Accordingly, the practice has been so to run the charge that the zinc passes off in the slag, and to a certain extent in the flue dust. The economical treatment of some ores has been impossible on account of the high percentages of zinc that they contained, and the consequent difficulty of separating the lead from the copper. Much interest is being aroused in the subject, and there is good reason to hope that careful investigation will in time ocercome this loss, and render available large quantities of ore now worthless. To make even an approximate estimate of the total loss of zinc is impossible, but it certainly exceeds thousands of tons daily."

In the early days of Leadville, the lead smelters imposed a penalty upon the ore whenever zinc was contained, and now that Leadville is again coming into its own—as a producer of zinc, however—the operators are confronted with a penalty whenever any lead is contained in the ore.

It appears that greater efforts have been expended in attempts at effecting a separation of the zinc-lead-copper minerals, by improved, or new ore-dressing methods, than to the separation by a direct smelting of the mixed products. The separation of galena from iron, copper or zinc minerals, in the course of the ordinary wet concentration of ores, offers but little difficulty, and a large percentage of the galena can be separated without great loss, and such sep-



The Fink Furnace Producing Blister Copper Directly from Zinc Ores

aration is always advisable where concentration must be resorted to by securing a suitable smelting product. The lead product so obtained can be collected until sufficient has accumulated to permit of separate treatment. The zinc-iron-copper minerals, however, do not differ enough in specific gravity to make their separation an easy one, and magnetic separation, as well as the various flotation processes, has been called into use in securing commercially clean products, the percentage of recovery varying greatly, as may be well understood upon studying the conditions under which the work is performed.

The writer has devoted many years of individual effort in attempts at securing a practical method of reduction for these complex ores and products, and finally concentrated his energies to devising a suitable smelting process, in preference to the means of mechanical concentration.

A study of the reactions met with in smelting operations show that zinc is reduced from its chemical combinations in much the same manner as is lead or copper, yet as this reduction takes place at a temperature above the boiling point of zinc, this metal is volatilized almost as soon as it is reduced. Inasmuch as it is imposible to obtain a perfect reducing atmophere in a large reduction furnace, the zinc cannot be recovered as metal, but must be collected as oxide, containing more or less impurities. The tendency of zinc to enter the slag is well known, and this is taken advantage of as a means of getting rid of the zinc contained in copper ores, and any smelting method which has for its object the recovery of zinc, must offer means of recovering the zinc that has entered into the slag. It is obvious that a furnace designed for the reduction and volatization of zinc must permit the easy escape of the zinc-laden vapors. The ordinary blast furnace, as used for copper smelting, is not adapted to such method, as the descending column of ore, fluxes and coke offers too great a surface to permit the unobstructed passage of the zinc vapors, and cases are recorded where such furnaces were put out of commission through the accumulation of zinc oxides in the shaft. Some form of reverberatory furnace would appear to answer the requirements much better, as the gases from this type of furnace meet with no resistance in their passage to the escape flue.

From the very beginning the Bessemer converter suggested itself to me as possessing the greatest possibilities for melting copper-zinc ores, for the oxidizing action of the air blown through the matte should liberate the zinc contained, as long as any copper remains as sulphide, as the zinc is reduced prior to the copper; any oxide of zinc which might enter the slag, or be contained in the gangue, would be reduced to metal if it could only be brought into contact with the liquid matte, for the reaction between the sulphides and oxides would bring about the reduction. This latter requirement could possibly be met by the use of a revolving converter, and this was the fundamental idea upon which my future work was based. At the time my first tests were made, the large horizontal Bisbee type of converter had not as yet made its appearance, and all attempts at smelting ores in the older type of converter were more or less unsuccessful, owing to the difficulty of maintaining the refractory lining. Early attempts at lining these furnaces with refractory brick met with failure, as the lining, especially at the tuyere zone, would be consumed almost as fast as it could be put in, and all additions of siliceous matter to the charge proved of little avail. The reason for this is not hard to find when one considers that the air enters through tuyeres located near the bottom of the converter, far removed from the surface of the charge, and the iron oxide formed at the tuyere zone, being chemically very active at the prevailing high temperature, unites with the adjacent lining, in preference to any ore that may be floating on the surface of the molten matte. To utilize this selective action of the iron oxide, and render it of commercial value at the same time, the converters were afterwards lined with silicious ore, and from that time on the converter has rapidly replaced the older, and more cumbersome refining furnaces, so that at the present time the Bessemerizing of matte is quite as common in copper refining practice as is the Bessemerizing of pig iron in the production of steel.

The inconvenience occasioned by the frequent renewal of the lining was more than outweighed by the benefits derived in the use of the converter, otherwise this process of refining would never have attained the important position it now holds. While the converter is admirably adapted to the refining of matte, it is evident that a number of fundamental changes would be necessary before it could be used in smelting ores. One of the first requisities of a commercial furnace is a serviceable lining, for a furnace requiring relining every other day or so could never obtain a foothold in metallurgical practice.

To carry out the converter idea in a smelting furnace, and at the same time conserve the lining, was the problem to be solved, and effort was made to profit as much as possible from the accumulated experience in copper converter practice. If the iron oxide formed during the regular converter operation is sufficiently active to disintegrate the lining, why should it not unite with the gangue accompanying an ore charge? Obviously, to prevent the eating away of the lining in the region of the tuyeres, it would be necessary to introduce the air at a point where the iron oxide formed would be in closer proximity to the unsmelted ore than to the more refractory lining. To accomplish this necessitates the introduction of the air from above the charge and away from the lining, as opposed to the method now in use. While years of smelting practice have shown the futility of blowing air over a liquid charge of matte in attempting the oxidation of the matte, the conditions are different, as soon as we deal with a partially fused charge, and especially if the semi-fused charge is agitated so as to conitnually expose fresh surfaces of ore, for under such conditions a rapid desulphurization takes place. The modern "pot roasting" methods are somewhat analogous to this method. Tests in a small way showed that a still more rapid desulphurization could be attained by forcing the air against the mass through a blowpipe, and small lumps of semi-fused ore would immediately melt and form a liquid pool, upon coming within the range of the air-blast. The use of blowpipes instead of the ordinary tuyeres formed the fundamental idea of overcoming the difficulties in maintaining the converter lining, for by their use the greatest heat of chemical reaction is generated within the ore itself, and away from the lining.

A small laboratory furnace was constructed embodying these features. It was a small horizontal sheet-iron cylinder, lined with refractory brick, and open at one end only. This opening served for the introduction of the ore, gasoline, air and for the manipulation of the blowpipe, the waste gases escaping through the same opening, yet above the point where the fuel was introduced. Various substances were tried in obtaining suitable blowpipes, a porcelain tube giving the best satisfaction, though graphite was also fairly serviceable. The blowpipe was manipulated by hand, and by directing the blast to the various portions of the ore, it was possible to smelt the charge in less than one-half the time required without the use of the blowpipe. Slag and matte were tapped after the charge was smelted, and the matte subsequently recovered from the slag upon cooling. The matte from a number of charges was united and refined, sufficient silica being added to combine with the iron, the operation being conducted in much the same way as the previous smelting operation, with

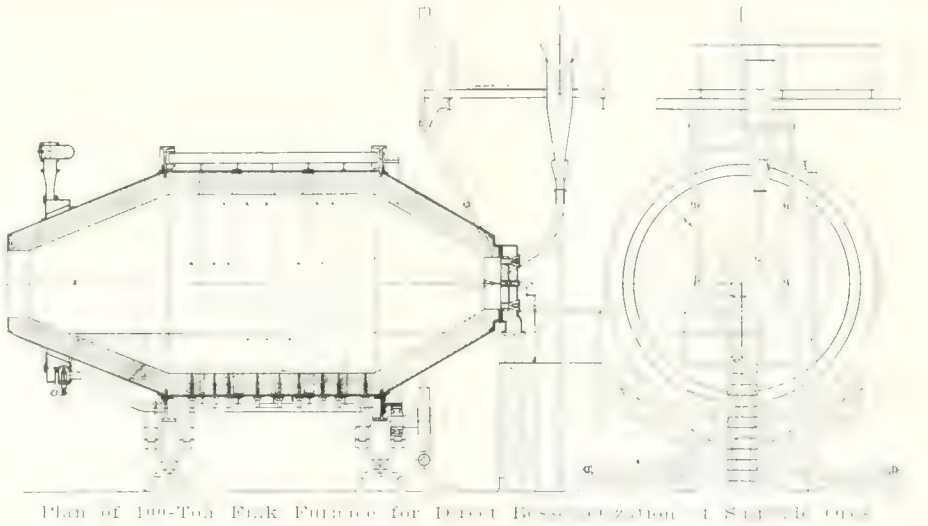
the exception, however, that in the refining operation the blowpipe was introduced into the matte, and served the additional function of a stirring device. It was possible to produce good-sized copper buttons in this furnace, and a very satisfactory removal of zinc could be effected, without any particular effort, as the slags contained but a fraction of 1% of that metal. These laboratory tests were highly encouraging and the carrying out of the process on a commercial scale was then attempted at Garfield, Utah.

FIRST COMMERCIAL TESTS.

The Garfield installation comprised two furnaces, placed end to end, yet separated by a connecting flue, the idea being the utilization of the waste heat from one furnace in heating a fresh charge in the second furnace, and after pouring the smelted charge and introducing a fresh charge, the second furnace, in which the charge was preheated by the waste heat from the first furnace, now received the initial supply of fuel, becoming the smelting furnace, while the first furnace became the heating furnace. In order to agitate the charge, the furnaces were made to revolve, yet in other respects they were very similar to the smaller laboratory furnace previously used. There were many structural difficulties to overcome, but the problem of maintaining the movable blowpipes was by far the most serious of the troubles met with, and finally caused their abandonment entirely. As long as they were used as blowpipes only, they proved fairly serviceable, yet when they were introduced into the matte during the final refining operation, much difficulty was experienced in preventing the accumulation of large lumps of chilled slag, at the end of the blowpipe, causing no end of trouble.

At this time, I will not enter into a recital of the Garfield smelting tests, yet in justice to myself, I cannot refrain from disclaiming responsibility for the many sensational statements sent out from Salt Lake City at the time. The representatives of The Mining World, as well as of other publications were more than anxious for an authoritative statement from me, yet all such requests met with refusal, for the furnace at that time was far from a commercial success, and I did not feel justified in making a statement.

While the furnace at Garfield failed to achieve the success attending the early laboratory experiments, thus again proving that correct theory does not necessarily spell commercial success, I was able to make certain observations that threw a greater light upon the problems involved. Upon introducing a charge of concentrate into the heated furnace, the matte forming ingredients rapidly melted and separated from the more siliceous gangue, which now formed a coating upon the lining as the furnace was rotated, the thickness of the coating being largely dependent upon the rapidity of feeding the ore, and was only entirely removed during the final refining of the matte. This observation clearly suggested an easy method of obtaining a siliceous lining in a converter, and a new furnace was designed to try out the discovery. As it was necessary to provide a revolving furnace, the prevailing "Anaconda" type of converter was abandoned, and a horizontal cylindrical furnace substituted therefor. Being a smelting furnace, suitable provision must be made for supplying fuel and ore, as well as air for the combustion of the fuel, in addition to the air supplied to the tuyeres. In order to permit of continuous operation an end opening was provided for the introduction of the ore and fuel, and one for the escape of the gaseous products of combustion. The tuyere boxes must be provided with means for regulating the air supply, so that the full pressure is available during the time the tuyereres pass underneath the charge, while the supply is gradually cut off as the tuyeres pass out from the molten bath.



Plan of 100-Ton Fink Furnace for Direct Reduction of Sulphide Ores

Being fully informed as to the requirements of the furnace, it would appear a simple matter to design an apparatus that would at once meet every requirement, yet where a radical departure such as this is attempted, many unforeseen mechanical problems are encountered when least expected, and the final completion of the work is carried far beyond the time originally allotted.

SECOND EXPERIMENTAL PLANT.

Anticipating many of the mechanical problems to be overcome, the second experimental plant was located almost within the city limits of Milwaukee, so that the highest specialized talent of the country could be called upon if need be, this being considered of greater importance, in this instance, than a convenient ore supply, and the wisdom of this decision was clearly demonstrated on more than one occasion. One by one the mechanical difficulties were met and removed, until finally a furnace was obtained that answered all requirements.

NEW FURNACE DESCRIBED.

The furnace is provided with two tuyere boxes, one of which is plainly shown extending along the cylindrical portion of the shell, as is also the air supply pipe, with its air regulation valve, extending from the wind-box along the conical end and through the trunnion to the tuyere box. The segment supported from the stationary ring of the wind-box by three cast-iron arms is the cam plate, which serves to open and close the air-supply valves connected with the tuyere boxes. The wind-box consists of a stationary part, to which is connected the air pipe leading to the high-pressure blower, and a movable part which contains the connections to the tuyere boxes, all of which is clearly shown in illustration. The wind-box contains a central opening communicating with the interior of the furnace, through which the ore is introduced, a cast-iron door swinging from the stationary ring preventing the flame from escaping at this end. This door contains, aside from the feed-pipe opening, two openings for the admission of air, and a smaller opening through which the burner nozzle is introduced. Opposite the air admission openings are two pipes, which discharge air into the furnace from a Connersville blower, which air is heated by a hot blast arrangement located in the main flue. The two openings for the admission of air also serve as a convenient means for observing the interior of the furnace during the smelting operation, as they are always clear and free from

smoke. When oil is used as fuel this is heated to near the flashing point, in order to obtain immediate combustion upon spraying into the furnace, and it is to prevent the chilling of this oil that the air is heated as described. The oil is atomized through pressure alone, making the combustion absolutely noiseless, and removing the disastrous blowpipe effect upon the lining so often obtained when air or steam is used to atomize the oil. The large curved pipe showing a portion of the feed hopper is the ore supply pipe, a better understanding of which may be obtained by studying the drawing showing the proposed 100-ton furnace. An ore seal is provided which prevents any back pressure from the furnace from communicating with the feed hopper, the ore being fed by revolving the disc shown, the rate of delivery depending upon the speed of revolution of the disc. Air is supplied to the feed pipe below the hopper, and by maintaining a flow of air into the furnace, the feed pipe is kept cool and free from flame and smoke.

The furnace is shown in the process of discharging slag, and by lowering or raising the furnace it is possible to accelerate or stop the flow. This process is wholly within the control of the operator, and the slag may be poured without disturbing the matte that has collected in the lower part of the furnace.

It is well to mention that the tuyeres are preferably left open to a very small extent, upon emerging from the ore charge to the time they are again about to be submerged, for by this operation the closing of the tuyeres would be entirely prevented, and, moreover, affording a much better mixture of the gases in the furnace than is otherwise the case.

Contrary to the experience obtained at Salt Lake City, the present furnace meets every requirement placed upon it, demonstrating the correctness of the theory, as well as its practical application. In direct contrast to the extreme corrosion of the ordinary converter lining at the tuyeres, the tuyere blocks in this furnace are scarcely attacked at all, which may be attributed to the chilling effect of the blast on the slag, as the tuyere leaves the matte, whereby a protective coating of slag is formed. Another remarkable observation in the operation of the furnace is the fact that the tuyeres seldom become obstructed, and "punching" is rarely necessary. This is probably due to the fact that any obstructions which might form, are smelted away during the progress of the tuyeres, from the time they leave the bath until they are again submerged, for during this time the openings are subjected to the direct heat of the smelting chamber.

Where more than two tuyere boxes are contemplated, as shown in the drawing for the proposed 100-ton plant, these must be so spaced that they may all be brought above the line of the molten charge, when it is desired to tap slag, in order to effect a quiet settling of the matte, which, of course, could not be obtained if the tuyeres were submerged and discharging air through the molten mass.

METHODS OF OPERATION.

Having now described the salient features of the new furnace, I will give a brief account of its operation. The furnace is first brought to a smelting heat by means of the oil flame, and the air from the high-pressure blower is discharged through the tuyeres. Ore preferably crushed to the size of walnuts, or finer, is now introduced through the feed pipe, the turning of the furnace preventing any accumulation at the feed end. If considerable sulphur is present in the ore, as in the case of concentrates, smelting takes place almost immediately, for the desulphurization is extremely rapid. The heated-air blast supplied by the Connersville blower is also a great aid to the desulphurization of the ore, in addition to supplying oxygen for the combustion of the fuel. The tuyeres, upon passing through the molten matte, cause a shower of small particles to be projected against the walls of the furnace, and in this finely divided condition the matte is most readily oxidized, and the period of desulphurization is greatly shortened. This fine spray of matte and slag exerts an absorbing influence upon any dust which may accompany the ore, so that the amount of flue dust produced is quite negligible. Any zinc in the ore is rapidly driven off during this smelting operation, and the matte which is collected is also quite free from zinc. The slag is poured from time to time, while the matte is allowed to accumulate until enough has collected to warrant further refining, at which time the slag is poured as completely as possible, and if the walls of the furnace now show an insufficient coating of siliceous matte, siliceous ore is added, although this is seldom necessary, since the matte originally produced is usually "white metal" containing but traces of iron, which requires only further oxidation for the production of blister copper.

The average copper contents of the slags produced was between 3 and 4-10ths of 1%, while the copper recovered was 99% pure, the assays being made by Dickman & Mackenzie of Chicago. At the present time no facilities are at hand for the collection of the zinc, and the only estimate which can be made as to the percentage eliminated, is based solely upon the absence of zinc in the slag, as well as in the finished product. At a future date an equipment will no doubt be installed to effect the actual recovery of the zinc, although the tests already made have fully demonstrated the correctness of the theory upon which the process is based.

While no tests have been made in smelting lead ores on a large scale, preliminary tests have given great encouragement, and I hope shortly to be able to report the results of some interesting tests, for, contrary to the general belief, the successful Bessemerization of lead sulphide ores is by no means hopeless.

While the smelting tests thus far made utilized oil for fuel, it must not be supposed that the furnace is limited to this form of fuel, as coal or charcoal may also be used to advantage. In case the latter forms of fuel are used, it is not necessary to reduce them to dust, and blow them into the furnace, as they are preferably fed in lump form with the ore, the combustion being brought about largely through the air from the tuyeres, the heat generated being in direct contact with the ore, rather than supplied by radiation from the furnace walls, as is the case when oil firing is used.

The furnace has not, as yet, been used for smelting carbonate ores, although there is no reason why it should not be applicable to this class of ores also, it being only necessary to supply a greater amount of carbon to the charge, and the tuyeres, instead of passing completely underneath the charge, should be stopped before the metal is reached, much in the same manner as in the refining of matte.

Although the furnace was primarily designed for smelting refractory zinc-copper ores, there are many advantages achieved in the smelting of strictly copper ores, also, as it enables the smaller producer to turn out blister copper, and, combining as it does, both smelting and converting operation in the same apparatus, great economies are achieved, both in the construction of the plant and in the operation thereof Whatever gold and silver may be contained in the ore is recovered with the copper and may easily be separated by the usual electrolytic method.

With fuel at 3 cts. per gallon, the average cost of smelting should not exceed $2 per ton, recovering the copper as blister copper, while the zinc is obtained largely as oxide.

A corporation known as the Fink Smelters Co., with the necessary financial backing has been organized to carry on all business in relation to supplying or operating the new smelting furnace.

ORE CONCENTRATION ON TREMENDOUS SCALE

The production of merchantable iron ore, by means of wet concentration, from material which is too low-grade for profitable reduction in the blast furnace, is one phase of the great iron and steel industry which is in its infancy, says a writer in the Metallurgical and Engineering Magazine. That it has been successfully done on a large scale, leads to the belief that it is an important step toward the genuine conservation of our iron resources, and one that will be followed by others which, in time, will make available much ore now without commercial value. This means not only the utilization of low-grade deposits, but the conservation of the best ore for special purposes, or for raising the average grade and quality of a large tonnage of less desirable ore.

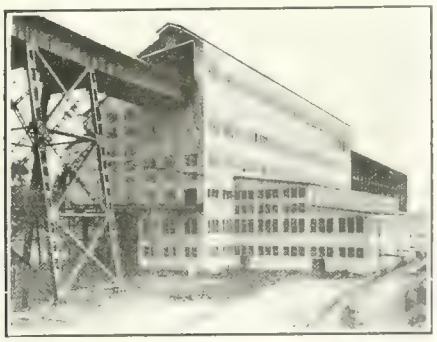


Fig. 1. Iron Ore Concentrating Plant of Oliver Iron Mining Co., at [illegible]

Special systems of concentration have had to be devised to meet the requirements of iron-ore production. The intrinsic value of a ton of iron ore is not great enough to warrant too elaborate a system of treatment, while smelting conditions demand an ore with as much lump and as little fine as possible. Tonnage and physical condition of the product, therefore, become important factors in this business. The former is equally important in the treatment of other low-grade ores, such as gold or copper. In these cases, however, it becomes necessary to resort to elaborate systems of grinding and fine concentration, which, fortunately, can be dispensed with in the concentration of iron ore.

In point of tonnage capacity of a single plant, there are no other ore-dressing mills in the United States which approach the magnitude of the largest iron concentrator. The great copper concentrating mills of Utah and Arizona, having individual capacities ranging from 3000 to 12,000 tons in 24 hours, are still small compared with the Trout Lake mill of the Oliver Iron Mining Company, with its capacity of 35,000 tons in 20 hours. And yet, owing to the more complex flow-sheet of the former, and consequently the larger number of machines used and greater acreage covered, they make an impression more nearly in keeping with their magnitude than does the iron concentrator.

TROUT LAKE MILL, OLIVER IRON MINING CO.

The first and larger of the two iron concentrating mills in Minnesota, was built by the Oliver Iron Mining Company, on Trout Lake, near the western end of the Missaba range, where the ore is lower grade than it is farther East. Here, also, the company has built the model town of Coleraine, beautifully situated on the north shore of the lake, and made attractive by substantial buildings, good schools, broad streets, cement curbing and sidewalks, and a system of artistic street lighting.

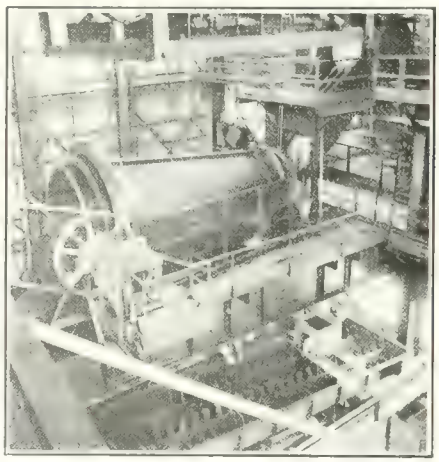


Fig. 2. Interior of Concentrator of Wisconsin Steel Co. Showing Screen and Log Washer.

An exterior view of the mill is given in Fig. 1 and a flow sheet in plan and elevation in Fig. 2. The railway approach to the mill is over a long fill of earth and rock removed in stripping the iron deposits. This approach ends in a steel trestle, shown in the figure, reaching a height of 110 ft. above the ground, and giving the necessary elevation for a gravity flow of ore through the mill.

UNIT CONSTRUCTION.

The flow-sheet, Fig. 2, represents one of the five units, each under independent control. The capacity of each unit is 350 tons per hour, and as the mill is operated during two shifts of 10 hours each, or 20 hours per day, the capacity of the whole mill is 35,000 tons per day. The crude-ore bin for each unit will hold 500 tons of ore, or about 1½ hour-supply for the unit. The views shown in Figs. 4 and 5, although taken in another plant, represent similar construction in a unit of the Trout Lake mill.

As shown in the flow-sheet, the concentrating machines of a unit are one conical screen (2-in. openings), two 25-ft. log-washers, two 18-ft. turbo-washers, and twenty Overstrom concentrating tables, with the necessary complement of settling tanks, pumps and bins. The ore is sluiced from the bin onto a grizzly (6-in. openings), where large pieces of waste rock are sorted out, and large pieces of ore broken to pass on to the conical screen. The oversize of the latter passes onto a picking-belt (Fig. 5), the rock being picked out and discarded,

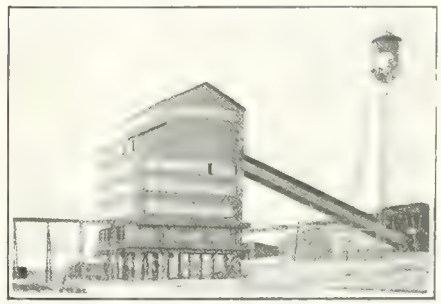


Fig. 3. Iron Ore Concentrator of Wisconsin Steel Co., Nashwauk, Wis.

while the lump concentrate passes on to the bin.

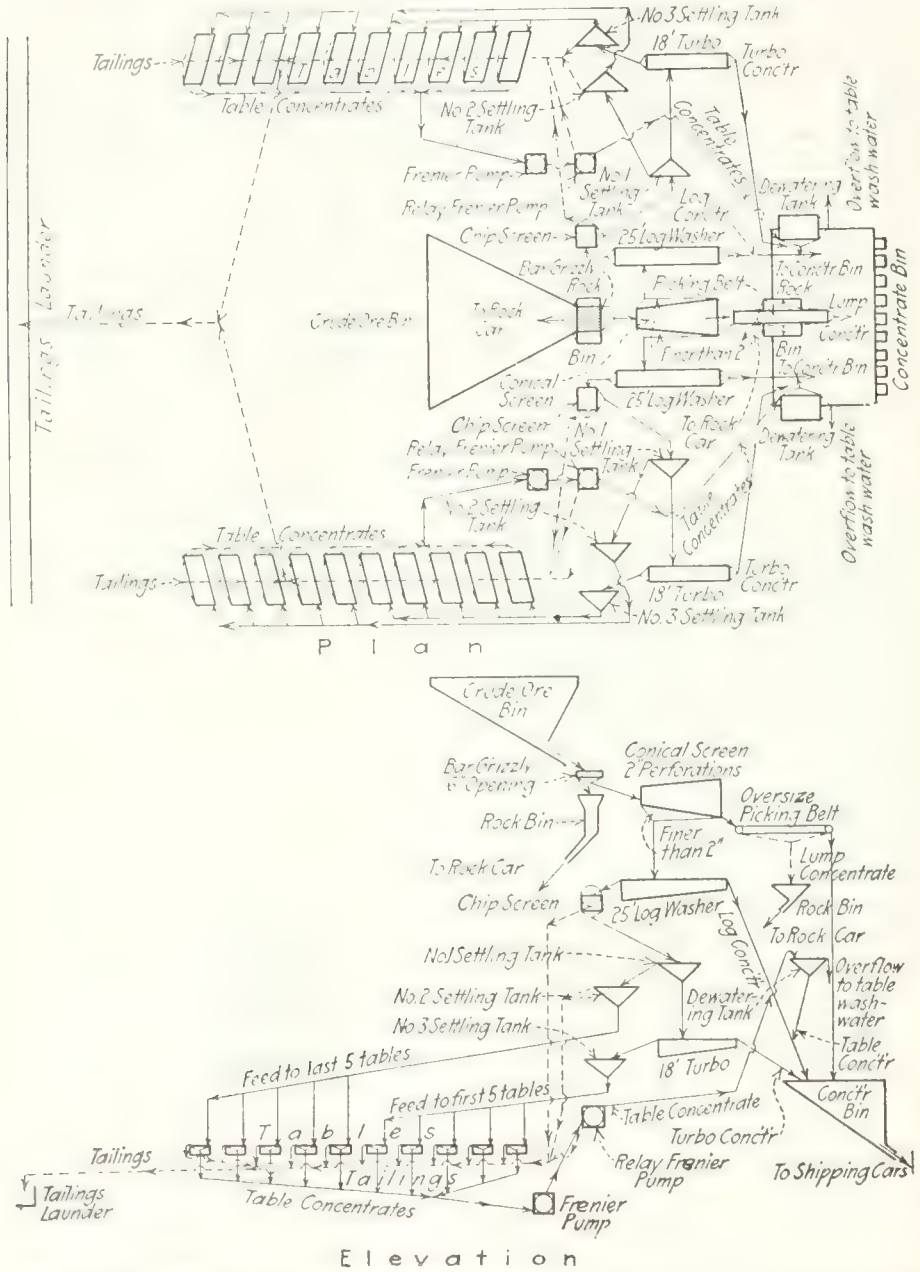
The 2-in. undersize of the screen flows to the log-washers on either side (Fig. 4). These machines produce a coarse concentrate which passes to the bin, the overflow being thickened and treated in the turbo-washers, which are practically smaller log-washers in which the feed is kept well agitated by numerous jets of water rising from the bottom of the casing. Between the logs and turbos are so-called "chip" screens or trommels, to separate and remove "chips" of rock

which are carried in the overflow of the log-washers. The turbo-washers produce a smaller size concentrate, and their overflow is thickened, and treated on tables. The table feed is clearly shown in the flow-sheet. The table concentrate is elevated by Frenier pumps, in two stages, dewatered and sent to the bin.

A 100-hp motor drives the conical screen, log and turbo-washers, and a 15-hp motor serves the twenty concentrating tables. The perforated plates of the conical screen are ½ in. high-carbon steel, and last about 100 days. The chilled-iron paddles on the logs last from five to six months. The decks of the Overstrom tables have been remodeled to suit the conditions, by removing the riffles and substituting a corrugated wood surface. This change resulted in increasing the efficiency of this department nearly 50 per cent.

The grade of the crude ore as it comes from the pits ranges from 35 to 42 per cent iron. The concentrate averages 57 per cent iron, and represents about 67 per cent by weight of the crude ore treated. The phosphorus content of the concentrate is slightly greater than that of the crude ore. All tailings are combined and sent to the Lake through a concrete flume, seen at the right in Fig. 1.

The pump and power station is situated on the shore of the lake, about 1¼ miles below the mill. The power plant, consisting of boilers, engine and 1250-kw generator, is capable of supplying twice the amount of power required in the mill, but the capacity of the pump is not much greater than the steady mill demand of 8000 gal. per minute. Water is raised a total height of 255 ft. above the lake, being delivered through a 30-in. pipe-line to a 110,000-gal. tank erected on a steel structure near the mill. The tank is in no sense a storage reservoir as it holds only about 15-minutes supply, but simply provides the necessary head of water for the mill.



Flow Sheet, Trout Lake Concentrating Mill, Oliver Iron Mining Company, Coleraine, Minn.

THE WISCONSIN STEEL COMPANY'S MILL.

The second iron-ore concentrator built in Minnesota was erected by the Wisconsin Steel Company, to treat ore from the Hawkins mine at Nashwauk. With the exception of some changes, which will be noted, it was modeled after the Trout Lake mill, in which a test run of 1000 tons of Hawkins ore was made, to see what results could be obtained. The two main points of difference are in the method of delivering the crude ore to the head of the mill, and in the extent to which fine concentration is carried. In the Nashwauk mill, Fig. 3, the ore is elevated from the railroad ore-pockets by means of a belt conveyor, passing then through a concentrating system similar to that at Trout Lake, except that no concentrating tables are used.

By reference to Fig. 3, it will be seen that ore is delivered by railroad to two ore-pockets of 250-tons capacity. Below the pockets are shaking launders arranged to deliver to a common point. In operation they discharge alternately onto a 3-ft. rubber-belt conveyor set at an inclination of 19 deg. The conveyor is about 150 ft. long and discharges ore onto a 6-in. grizzly at the head of the mill at a point corresponding to the mouth of the crude-ore bin in the Trout Lake mill. The head pulley of the conveyor is discernible in the upper part of Fig. 3.

The operation of the shaking launders is controlled by one man at the ore-pockets, and the movement of the belt conveyor is governed by the men at its upper end, whose duty it is to sort out waste rock and break large lumps of ore which will not pass the grizzly. Should it become necessary to stop the belt, the man at the feeders is signalled by an electric bell, and the feed is temporarily stopped.

The advantages claimed for this system are: First, that it avoids the construction of the long approach required to deliver carloads of ore to the head of the mill; and second, that a more regular feed is insured by eliminating the possibility of sudden rushes of great masses of ore, which sometimes occur in a large bin. Irregularity of feed, of course, subsequently affects the efficiency of the screen and the log-washers,

as well as the quantity and grade of concentrate produced.

The decision to omit the concentrating tables in the Nashwauk mill was determined by the fact that only 3 per cent additional recovery could be made by their use; and the ore thus recovered, being fine, would be the least desirable of all the concentrates. When dry it would practically be dust, subject to loss in transportation as well as in the blast furnace, and altogether hardly worth the outlay of capital and operating expense for fifteen or twenty tables.

With the exceptions noted, the concentrating system at Nashwauk is practically the same as at Trout Lake. A minor difference is the use of small grizzlies instead of chip-screens to remove large particles of lean ore and rock from the overflow of the log-washers to the turbo-washers. The punched plates in the conical screen show about the same life as at Trout Lake. When the blades of the log-washers are worn thin, they are not removed, but are patched with pieces of white-iron bolted to the worn blades. The white-iron blades last from five to six weeks.

All concentrates are delivered to the same bin, and in order to mix the coarse and fine, a part of the stream of log-concentrate is diverted to the launder carrying turbo-concentrate before the latter enters the bin. Tailings flow out of the mill through an elevated launder which discharges onto an area of low land where the solid tailing accumulates, and the water drains back into the small lake near which the mill is built.

CONCENTRATION RESULTS.

The ore treated at Nashwauk is higher grade than at Trout Lake, and the product is proportionately of better quality. The crude will average 40 to 45 per cent iron and 15 to 16 per cent silica. The mixed concentrate averages 60 to 62 per cent iron and 3 to 6 per cent silica. Phosphorus is about two points higher in the concentrate than in the crude ore. It has been found profitable for the purposes of this company to concentrte crude ore containing up to 56 per cent iron. Eighty per cent f the iron in the crude ore is recovered, and the concentrate represents about 62 per cent by weight of the crude ore. Of the total product, 10 per cent is lump concentrate from the conical screens and picking belt, 80 per cent coarse concentrate from the log-washers and 10 per cent fine concentrate from the turbos. Sampling is done twice daily, all the concentrates being temporarily diverted to a steel bin provided for this purpose.

Steam-electric power is generated by a Parsons turbine and 500-kw generator, which gives power greatly in excess of the 125-kw required in the mill. The main unit is operated by a 100-hp motor, as at Trout Lake. The belt conveyor consumes abou 30 hp and the shaking feeders about 10 hp. A Prescott steam pump of 2500 gal. per min. capacity supplies water to the mill, the consumption being only 1200 gal. per min. This is proportionately less than is used at Trout Lake, due largely to the omission of the tables.

IRON-ORE CONCENTRATION A RECENT DEVELOPMENT.

The mills described are in operation only six months in the year, corresponding to the regular shipping on the lakes. The Trout Lake mill has finished its third season, and the Nashwauk mill its first. It is interesting to note that both mills far exceeded their rated capacities,

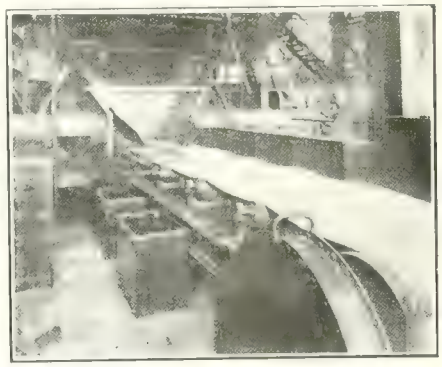


Fig. 5. Picking Belt Below Screens at Wisconsin Steel Co.'s Plant.

practically by 100 per cent, and have given fully as good results as were anticipated. The Nashwauk mill was planned as a two-unit plant, but the single unit has proved ample for present needs, and the second may not be installed. As much as 8000 tons of ore has been treated in this unit in one day of 20 hours.

At Coleraine, Mr. M. H. Godfrey is general superintendent for the Oliver Iron Mining Company. Mr. Wm. Nicholls, who is superintendent of the Trout Lake mill, was formerly engaged at some of the large Western copper concentrtrators Mr. C. J. Mott is assistant superintendent. The Nashwauk mill is under the management of Capt. Sellwood, of Duluth. Mr. B. W. Batchelder, of Nashwauk, is superintendent.

THE VAPORATION OF METALS

By PROF. J. W. RICHARDS*

Most practical metal workers know that some metals are volatile. No one knows many exact facts about this mat-

Metals have vapor-tension curves similar to that of water. Water at ordinary atmospheric pressure boils at 100 deg. C., or 212 deg. F. But at lower pressures it boils at lower temperatures; at half atmospheric pressure it boils at one-tenth atmospheric pressure at 46 deg. C., and at one-hundredth atmospheric pressure at 7 deg. C.

A point not generally understood is that an indifferent gas in contact with a volatile substance acts like a vacuum as far as inducing evaporation is concerned. Water evaporates in a current of dry air at any temperature whatever; the only condition being that the dry air be renewed as fast as it becomes saturated with the water vapor. Even solid water, ice, will evaporate in a current of dry air, although the temperature remains below the melting point of the ice.

All that has been said of water is true of metals. They all have definite boiling points under atmospheric pressure, lower boiling points at lower pressures, and can evaporate at any temperatures down even to their freezing points, if the pressure is sufficiently reduced. They will also vaporize at low temperatures in the presence of an indifferent gas, if the latter is renewed as fast as it is saturated with the metal vapor.

To illustrate the above principles, let us cite zinc, which boils under atmospheric pressure at 920 deg. C., but which has an appreciable vapor tension at as low a temperature as 289 deg. C. or 130 deg. C. below its melting point. This tells us that not only will zinc evaporate rapidly when melted, in a current of indifferent gas, but that even solid zinc can give off zinc vapor. Similar facts are true, although in a smaller degree, of many metals ordinarily considered as non-volatile. Silver, for instance, can evaporate from solid ingots which are being heated by direct contact with a flame, the gases of the flame carrying away with them more or less silver vapor, just as dry air can carry off water vapor from ice.

Evaporation and voltilization of metals can best be avoided by melting them out of contact with currents of gases; that is, by heating in closed vessels. This can be accomplished either by melting them in crucibles with covers, or by using electric furnace heating. The latter is to be preferred, and will be found much less expensive for power than is commonly supposed. I believe, for instance, that brass can be, at the present time, melted more cheaply in electric furnaces than by fuel, almost anywhere in the United States, with great saving of the zinc usually vaporized.

*Abstract of a paper read at the Allied Foundrymen's Convention in Buffalo last month.

From Copper To "Gold Mines"

This space is reserved for the picture of A. F. Holden, the other eminent engineer who lent his name and gave his endorsement to the electrifying report on Alaska properties submitted herewith and which will be reproduced from month to month.

NOTED ENGINEERS JOIN BROKERAGE HOUSE IN A REMARKABLY PECULIAR PRESENTATION OF AN ALASKA GOLD MIRAGE.

We have received a few inquiries from readers who wished to know why we did not publish all of the "report" of Messrs. Jackling and Holden of the Alaska Gold Mines Company instead of the following "extracts." In reply we wish to explain that, if there ever was anything more than these "extracts" made public we have been unable to trace it. When Hayden, Stone & Co. sent out the letter inviting subscriptions to the stock they did it on the STRENGTH of the contents of these "extracts." Or that is the presumption, at least. That intending purchasers and investors at once became suspicious and have since kept hands off is indicated by the wording of nearly every line of publicity that has since been given the proposition. But read the "report" again. Here it is:

Extract From Report of Messrs. Jackling and Holden.

We have considered the PROBABLE capital requirements for a capacity of 6,000 tons per day, which contemplates a hydro-electric power plant; mine development and equipment including all the necessary living quarters, both at the Perseverance mine proper and at the mill, and driving the long adit tunnel. We BELIEVE that $4,500,000 will do this work.

Our belief is that the substantially INDICATED ore body is about 4,500 feet long by seventy feet wide. The value of the 600,000 tons of ore THAT HAVE BEEN MINED FROM THIS BODY IN THREE DIFFERENT LARGE STOPES INDICATES that a recovery of at least $1.50 per ton can be made. We BELIEVE that there will be 75 cents per ton profit in this grade of ore. The Sheep Creek Tunnel which will be driven on the vein as the main haulage level, will develop this ore body at an average depth of about 2,200 feet on the dip of the vein or about 700 feet deeper than present developments.

The character of this vein is similar in A VERY GENERAL WAY to other large deposits of gold ore in the same vicinity in which the values at a vertical depth of 1,600 feet, or 2,000 feet on the dip of the vein from its apex, are practically the same today as they were on the surface, and have been throughout the development of THE DEPOSITS IN QUESTION. We visited these mines and saw THEIR deep levels, and if there is any inference to be drawn from the continuity of THESE ore bodies, WHICH ARE NOT, HOWEVER ON THE SAME VEIN AS THE PERSEVERANCE, one MIGHT BE TEMPTED to say that there is a PROBABILITY of ore 2500 feet deeper than the so-called Sheep Creek Tunnel which we contemplate driving. BUT, while the PROBABILITY is there of the vein and values extending to great depth, THERE IS NOTHING TODAY TO WARRANT ANYBODY IN STATING THAT IT IS A FACT THAT SUCH WILL BE THE CASE.

There are substantially 50,000,000 tons in the ore body we consider definitely INDICATED. There is a PROBABILITY of another 2,000 feet to the east of the 4,500-foot ore zone previously mentioned which, from surface indications, would seem FAIRLY CERTAIN to contain ore. Beyond this is some 1,800 feet of the vein concerning which we have NO FINAL OPINION one way or the other, AS WE VISITED NO WORKINGS OR OUTCROPS from which we could secure sufficient data to form accurate deductions. While we cannot at this time state that there IS ore here, there were several SMALL MINES worked almost at the extreme east end of the vein on this property, which INDICATES that this 1,800 feet will undoubtedly produce considerable ore and PERHAPS LARGE QUANTITIES. If we do not consider this in the PROBABILITIES, it is certainly well within the POSSIBILITIES.

This letter is based solely on a consideration of $1.50 recoverable value as ore. If one should figure on lower values assuming 75 cents as the total cost of mining and milling, the tonnage now indicated is INDEFINITE, but certainly enormous. We BELIEVE that sound mining business will INDICATE that for the installation now proposed and for an operating period of, say, two years, IT WILL BE WISE TO CONFINE OUR WORK TO THE HIGHER GRADE ORE. There can be, in our opinion, little doubt that at some time in the comparatively near future A VERY MUCH LARGER PLANT than the one now proposed will be installed for the purpose of working a larger tonnage of the normal grade ore we now EXPECT will be developed, or of utilizing the apparently vast quantity of lower grade material.

The INDICATED earnings from the installation now contemplated are approximately $1,500 000 per annum. Considering the TREMENDOUS POSSIBILITIES, and we use the word "tremendous" advisedly, we BELIEVE this mine to be a LEGITIMATE purchase at $15,000,000 and A BARGAIN at $12,000,000, provided that, in both cases, a development,equipment and working fund of $4,500,000 is made available. You must understand and appreciate that we do not consider the 6,000-ton per day development and installation as the ultimate possibility of the mine or anywhere near it. The POSSIBLE tonnages of ore INDICATED in this property APPEAR to be greater than any vein deposit WE know about.

We EXPECT the first unit of the new mill to be in operation on or before January 1st, 1915. We really BELIEVE that, barring accidents the time MAY be made July 1st, 1914.

(Signed, July, 1912.)

D. C. JACKLING.
A. F. HOLDEN.

How Spelter Is Sold

By W. R. INGALLS*

The American zinc industry has escaped any general consolidation and there has not developed in it any single concern of sufficient power even to attempt to regulate the price. This may be ascribed primarily to the nature of the occurrence of the ore deposits which are worked in a multitude of mines whereof a general control would be a hopeless undertaking. Given therefore an open supply of ore and a metallurgical process for its reduction that does not so strenuously demand mixtures as does the process of lead smelting, the metallurgical side of the industry is also bound to remain open. There are other conditions favoring the maintenance of that condition, but what I have stated will suffice as a broad generalization. There have, indeed, been numerous consolidations of groups of works during the last 20 years, but these have been simply promotive of efficiency, not restrictive of competition. In many cases the vendors of works have promptly built new works with the money received for their old ones, and have successfully continued in the smelting business. With such an ability, what would be the use of any trust organizer buying up all the works of the country? However, there has been during the last 15 years a natural segregation of interest, which has been merely a manifestation of the modern tendency to substitute strong industrial units for small and weak ones, and this of course has had an effect upon market conditions, especially in the conversion of the brokerage houses into producers.

ELIMINATION OF THE MIDDLEMEN.

Twenty years ago the production of spelter was largely made by small concerns, mostly of small capital and frequently on the ragged edge of insolvency. Their policy was commonly to combine smelting and speculation and their purchases of ore and sales of spelter were largely governed by their forecasts of the market. When pinched by some unforeseen turn and caught with a stock of spelter on hand their lack of resources compelled them to unload at a sacrifice upon some one of the metal houses able to carry the stock and distribute it to consumers later on. These metal houses often were called upon to make advances to smelters and through the combination of their banking and merchandizing facilities became great factors in the business.

As the smelting industry became concentrated in fewer and stronger hands the necessity for such middlemen disappeared, and the latter being desirous of maintaining their well organized system of merchandising their only recourse was to go into the smelting business themselves, whereby their purview was extended beyond the production of zinc as spelter and to the zinc-ore market, but none has actually entered upon the production of ore.

THE SMELTING INTERESTS.

A list of the American zinc smelters has been published repeatedly, wherefore it is unnecessary to repeat it here, but it will be of interest to present a list of the controlling factors of the industry, which is given herewith:

Name.	Retorts.
Am. Zinc, Lead & Smg. Co., 3 wks.	11,188
American Metal Co., 3 wks.	11,810
Chanute Zinc Co., 1 wks.	1,280
Beer, Sondheimer & Co., 1 wks.	1,256
G. E. Nicholson, 2 wks.	5,696
Collinsville Zinc Co., 1 wks.	1,536
Edgar Zinc Co., 3 wks.	6,500
Granby Mg. & Smg. Co., 1 wks.	3,840
Grasselli Chemical Co., 1 wks.	7,216
Hegeler Bros., 1 wks.	1,800
Illinois Zinc Co., 1 wks.	3,460
Matthiessen & Hegeler, 1 wks.	1,480
Nevada Zinc Co., 1 wks.	618
New Jersey Zinc Co., 4 wks.	16,116
Pittsburgh Zinc Co., 1 wks.	448
Sandoval Zinc Co., 1 wks.	896
U. S. Zinc Co., 1 wks.	1,680
United Zinc & Chem. Co., 1 wks.	3,680

It will be observed from this list that there are five concerns each possessing upward of 6000 retorts. Of these the Edgar Zinc Co. is controlled by the United States Steel Corporation and supplies it with spelter to a large extent. There are seven concerns with less than 2000 retorts each. There are six concerns with from 2000 to 6000 retorts. Of these, the Matthiessen & Hegeler Zinc Co. and the Illinois Zinc Co. consume the major part of their product in the manufacture of sheet zinc. The New Jersey Zinc Co., the American Zinc Lead and Smg. Co. and the Granby Mining & Smelting Co. are the only ones of these smelters who have any mining interests worth mentioning.

KINDS OF SPELTER.

At the annual meeting of the American Society for Testing Materials in June, 1911, Prof. William Campbell, of Columbia University, chairman of the committee on "Non-Ferrous Metals and Alloys" reported a classification of the kinds of spelter, the figures representing the maximum percentages of impurities allowable. This classification is rational and corresponds substantially to the understanding among American zinc smelters.

The trade recognizes different grades of some of these kinds of spelter. Thus, "Horsehead" and "Bertha" spelters are considered to be superior to any other brands of high grade spelter and realize the highest premiums. "Glendale Refined" is, so far as I am aware, the only kind of intermediate spelter. This is made out of especially selected ore. Prime Western spelter corresponds to the "Good Ordinary Brands" of the European market. The bulk of the American spelter product is of this class. There is considerable variation in the quality of the several brands. Most of the Prime

KINDS OF SPELTER.

KIND	Pb.	Fe.	Cd.	Total not over
A. High grade	0.07	0.03	0.05	0.10
B. Intermediate	0.20	0.03	0.05	0.50
C. Brass special*	0.75	0.07	0.75	1.20
D. Prime Western	1.50	0.08		

*To be free from arsenic.

Western spelter is now made out of ore from the far West. There are some smelters who continue to use mainly a good grade of Joplin ore and produce a spelter standing between Prime Western and Brass Special and realizing therefor a small premium.

The price commanded by the high grade spelter is so much above that realized for Prime Western that to all intents and purposes it is a different metal. The premium runs anywhere from 2 to 4c per lb.† The premium for intermediate spelter is usually from 1 to 2c. per pound. Brass Special fetches a premium of from 5 to 25c. per 100 lb. The high grade and intermediate spelters are made by few concerns, which are able to command their own terms. Brass Special is made by many concerns and the supply of it is relatively abundant. In speaking commonly of the price of spelter, the price for Prime Western is meant.

MARKETING.

In the main the producers of spelter market their own spelter, i. e., they sell it directly to consumers. So far as I am aware there is none sold regularly through the metal selling agencies on commission‡ but these agencies not infrequently buy outright from some of the weaker smelters still remaining, who find among them an ever present market at a price. It goes almost without saying that with so many producers of spelter the competition among them to dispose of their product is keen. In this market in fact the common condition is reversed, the concentration being on the consuming side not on the producing. The

*Editor Engineering & Mining Journal in October 26 issue.

†The premium [illegible] were paid to [illegible] tors of the two [illegible] to reckon upon the [illegible] realized.

‡Exception [illegible] by L. Vogelstein & Co. [illegible] Zinc Lead & Smelting Co. [illegible] Sondheimer & Co., for the National Zinc Co., where the agents are interested in the [illegible]

United States Steel Corporation alone takes upward of 30% of the entire make of prime western spelter, and the activity in the spelter market is likely to depend upon whether that company is buying or not buying.

GENERAL CONDITIONS.

The conditions governing the marketing of spelter are in the main the same as in the marketing of copper which I have described in a previous article. The so-called "spot" business is essentially of a retail character, the main business in the metal being in contracts, which are made for a longer or shorter period ahead according to notions of what the future is going to develop. The stock of spelter in the hands of the smelters is always relatively small. Anything like 25,000 tons is considered large, but in fact that is only about the production of one month and includes all kinds of the metal. At some times there may be a practically complete disappearance of stocks, as for example, during the last year, and buyers who must have some metal for immediate delivery are likely to be required to pay stiff premiums, but such are in no way representative of the broad commodity market because but relatively little business is done under those conditions, the bulk being in contracts anticipating requirements.

When contracts are made for a long time ahead there may be a differential in the price, plus or minus, according to the preponderance of views respecting the future. Most of the smelters are governed by their position as to ore supply. Those who take in ore under contract, on a sliding scale, desire normally immediately to sell spelter against it. The trend toward a rising market must be very well defined and certain to cause them to adopt a policy of reserve in their selling. The smelter who buys his ore as needed or as offered will always be governed in his attitude toward the spelter market by the quantity and cost of his stock.

ST. LOUIS THE BASING POINT.

It become the custom in the American spelter market to adopt the price at St. Louis as the basis for contracts and business generally. The spelter may not even pass through there on its way to the buyers. Some spelter is actually sold in St. Louis, but a very large quantity is sold in New York on St. Louis basis. The price at New York, if ever it be necessary to refer to it, is simply the St. Louis price plus 15c. per 100 lb., which is the freight rate from St. Louis to New York.

St. Louis is a natural basing point, because the major part of the consumption of spelter in the United States occurs at places between it and New York. Upon the rare occasions when European spelter is imported through New York, as in September, 1912, New York may become an independent basis point and there may be a variation from the normal freight differential, but this is only temporary. Importations of foreign spelter will begin, of course, wnen consumers in the immediate vicinity of New York, or in Connecticut, can be supplied more cheaply than from the western smelting points, while the latter may still retain the interior market.

SPECULATION IN SPELTER.

There is more speculation in spelter than there is in copper. The fluctuations in the price are rapid and often violent, the sellers of spelter for distribution are numerous, no single interest is predominant, all of which conditions contribute to the absence of aversion to speculative participation in this market such as exists in the copper market. There are many smelters who will sell spelter to anybody who wants to buy it, hold the spelter and issue certificates representing it. These certificates may pass from hand to hand and be redeemed after five or six endorsements have been made on them. They correspond, of course, to any warehouse receipt. It is, however, only at times that there are general transactions of this kind.

Similarly as to transactions on the New York Metal Exchange. They are never of any great volume or significance. Long periods may elapse without there being any at all. Then several hundred tons may be sold in a day. These reflect speculative business. Consumers do not buy through the Metal Exchange. Most of the smelters do not try to sell through it or indeed pay any attention to it. Some smelters are represented upon it and may buy up what is offered there, especially if it be desired to clean up the market of speculative spelter. In the same way there are transactions from hand to hand in St. Louis, although there is no organized exchange there, the business being of the nature of that of a curb market. The entire volume of the business of this kind, both in New York and St. Louis is only a few hundred tons per month and is insignificant in comparison with the marketing of the bulk of the spelter product, which is done directly between producers and consumers. Almost without exception the smelters give preference to orders from consumers over orders from dealers, and frequently give the former as much as 5c. per 100 lb. advantage in price, and even more.

The real spelter market being established by private transactions between producers and consumers the information reflecting the market can come only from them. Among such transactions there are often considerable differences, the means of exchanging information in the spelter market being distinctly inferior to those of the copper market. Some consumers do considerable "shopping," Others do not. Some who do so ordinarily may upon certain occasions make a negotiation with some one smelter without letting anybody else know that he is in the market. The direct market, if I may use that term, is often quite different from the speculative, or semi-speculative, street market. The quotations made on the New York Metal Exchange do not ordinarily command any serious attention anywhere. Before accepting any quotations made there it is necessary to know whether anybody trading in spelter was present at the call and whether the price was the result f a genuine transaction. If nobody who wants to buy or sell spelter be present at the call it is easy of course to bid up, or offer down, the price ⅛ to ¼c. above or below the real market.

The conditions above recited explain the contradictory reports about the spelter market that frequently are in circulation. In cases of discrepancy the high figures are generally to be rejected on the probability that they represent merely prices that are squeezed on a small order required under special conditions or in speculative business that is small in volume anyway.

FOREIGN RELATIONS.

The tariff on spelter causes the American market to be independent of the European market during most of the time. Formerly, American smelters used to dump a good deal of spelter upon the European market at certain times, but during recent years no such opportunity has arisen. On the other hand, we have lately witnessed circumstances in which we were upon the verge of importing European spelter, duty paid, and have actually made such importations.* At these times the European market was a restraining influence to a further rise in our own. Similarity, upon other occasions, the possibility of exporting spelter has checked a decline in our market. Except for these conditions the European market and American market may display wide disparity and doubtless will continue to do so so long as our producers are protected by the tariff on zinc ore and spelter.

*We are, of course, importing foreign zinc ore all the time and smelting it in bond the product being exported or entered for consumption according to the market conditions of the moment. The duty on imported spelter is 1.5c per lb., on zinc in ore, 1c per lb.

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CONTENTS:

Have you noticed how little the liquidation in the stock market during the past month has affected Alaska Gold Mines shares? Its great strength and steadiness is most likely due to the fact that the public has so far had sense enough to steer clear of it. Utah Copper holds "strong" for almost the same reason, the difference being that while Alaska has never left the hands of the insiders, most of Utah Copper shares that had been "distributed" have gradually gone back home during the market supporting "movements" of the insiders

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Hang on to the bed-post and let this, from the mining department of Goodwin's Weekly, whiz by; if you let go it is possible you will fall into the fireplace: "The hills and flats are producing millions of pounds of copper. Hence copper can be made from nothing. Col. D. C. Jackling, the man who "makes mole hills out of mountains" was the wonder worker in this instance. * * * The convivial husband no longer will seek to deceive his distrusting wife with cloves, limberger or such sorry make-shifts; he will buy a paper and read about the Jackling coppers."

D. C. JACKLING INTERVIEWED ON BUTTE AND SUPERIOR

The Anaconda Standard of Monday, December 9, contained an interview with General Manager D. C. Jackling, of the Butte and Superior company, "before the Salt Lake mining magnate left for Alaska, where he will spend a month inspecting HIS properties in the Juneau district." Mines and Methods reproduces from the article the portions having particular reference to the changes being made in the Butte and Superior mill, as follows, the capitalization of words being our own:

"While our new section of the mill has not been running long enough to make any definite statement as to the complete efficiency of our new process, we are confident that we have installed the correct system and from our three-day run, in addition to the EXHAUSTIVE TESTS that the system had been given before the installation of the new section, we BELIEVE we are on the right track," he said.

Mr. Jackling added that THE NEW PROCESS IS MUCH ON THE ORDER OF THE PROCESS USED IN THE TREATMENT OF THE ORES OF THE UTAH COPPER COMPANY THROUGH UTAH AND NEVADA. A roughing table takes the place of jigs and THE PROCESS IS A DRY ONE instead of the WET SYSTEM formerly used.

The new section will treat 600 tons of ore each twenty-four hours, and with the other sections of the mill changed to this process, the tonnage of the Butte & Superior will be nearly 1,800 tons per day.

"Our new process of treating the highly refractory zinc ores is most satisfactory and it means a great deal to your community," said Mr. Jackling. "The north and some of the east sections of the Butte district are wonderfully rich in zinc, but heretofore a solution for a process of treatment has been most difficult as well as expensive. We have every reason to BELIEVE that the difficulty has been solved.

Manager Jackling's statement concerning the merits of the new "solution for a process" should not, we think, be taken too seriously by either investors or engineers. The substitution of roughing tables for jigs and making the process "a dry one instead of the wet system formerly used," (whatever is meant by that), does not seem to indicate much in itself. Neither is there any satisfying assurance in the statement that "we have every reason to BELIEVE that the difficulty has been solved." Orther statements of the general manager in the paragraphs quoted above are fully as lacking in conviction and, when we stop to think of the change after change made in the Utah Copper, Ray Consolidated and other milling plants directed by Manager Jackling with such barren results—from an economic and metallurgical standpoint—we may be pardoned for expressing the opinion that the manager was not overly sure of his ground when he admitted to the Standard reporter that "we BELIEVE we are on the right track," nor that he was not even then evolving ideas for additional "remodeling" campaigns for the future.

Mines and Methods is not questioning reports concerning the great magnitude of the zinciferous ore deposits in the Butte district, nor will it be displeased to hear that the Butte and Superior company has found a method by which the ores can be made to yield a product that can be profitably marketed. It is reported that Senator W. A. Clark, rated as one of the shrewdest mine operators in the world, is employing the best available metallurgical and engineering talent in a determined effort to discover a method by which ores similar to those contained in the Butte and Superior property, and opened up in his mines, may be profitably handled. He has not as yet been successful, though of course his engineers are not ignorant of the methods employed at the Utah Copper plants, the Ray Consolidated or Nevada Consolidated.

Before it is possible to judge what advancement the Butte and Superior management has gained with its new "dry" process over the old "wet" one, shareholders in the company will (or ought to) require enlightenment on many things connected with the operation of the process. An explanation of the characteristics of the ore, what elements go to make its treatment difficult; what grade of product must be made to get results in the market; what the mill was doing before the changes were undertaken, and wherein a betterment of results is secured by the change. While the Butte and Superior company is rated as a powerful one and the expense of frequent remodeling could be borne as easily as it has been by the Utah Copper and other companies, the shareholders will hardly be content with reports showing simply that so many tons of ore were treated and so many thousands of pounds of zinc were contained in the concentrates—that will not mean much in its application to such rebellious material as the zinc ores of the Butte district are known to be.

MARKETS "FUNDAMENTALLY" SOUND

All followers of the market dope on copper production and consumption, and particularly as it has had anything to do with the ups and downs of prices of the stocks representing the "leading low-grade porphyries," must have noticed the well-worn use that has been made during the year of the word "fundamental," with all the prefixed and affixed glowing raiment with which it has been clothed. When the talent has been shooting holes in the market, such dopesters as Babson, Shotwell, Walker, Ben Hite, Hayden, Stone & Co., and the Boston News Bureau, have all made it "as plain as mud" that all conditions were "fundamentally sound."

But, as the year draws to a close, it is painfully evident that none of these "authorities" have cut even close to the mark. Maybe they have not tried to. At any rate that is the most charitable view to take of their efforts; and if they have not tried to be fair with the public they are all guilty of saying things designed to interest the public in stocks which they knew to occupy positions they were not entitled to occupy and which, if purchased, would bring financial disaster to those who followed their market prognostications.

A few months ago most of these public advisers gave space to figures showing that the visible supply of copper in the world had dropped to less than 100,000,000 pounds; that "fundamental condition" were such that, before the end of year 1912, the world's markets would be stripped of copper metal and that "a runaway market" was to be "feared."

The Copper producers' report for last month must have been an awfully bitter pill for the "bull market" dopesters to swallow. It read as though some of the producers had become tired of the deception that had been going on and that it was time to straighten things out a little. The report in question was made to show that the visible supply of copper had increased during he month 9,419,095 pounds, and that in face of the fact that production had decreased during the same time 10,710,013 pounds. Further than that, the report shows that the world's supply of the red metal, instead of being about wiped out as predicted by the "dopesters" enumerated above, is again nearing the 200,000,000-pound mark. Domestic deliveries, under the "fundamentally sound" conditions so industriously paraded fell off more than 14,000,000 pounds during November, with the export market looking gloomy, as well.

It is all right to take a cheerful view of things and thus help to remove distrust and make business conditions better, but to distort the truth and hide true conditions for the purpose, merely, of aiding the manipulation of stock-distribution schemes of most questionable character, is something that ought to be stopped by the postoffice department, if it is impossible to reach it in any other way.

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BRAND NEW METHODS OF FIGURING ORE RESERVES

According to statements made in the syndicate press for the low-grade porphyries a new and rather unique method of piling up tonnage reserves has been discovered. The first illustration of the new scheme has been applied to Chino. One of "two authorities" is made to say:

> It will be recalled that the latest official estimate was, approximately, 55,000,000 tons, averaging 2¼ per cent. In mining this ore, however, a very large amount of other material will have to be moved.
>
> In previous calculations this has been looked upon as waste. As a matter of fact, it contains very large quantities of ore of low grade, which, with the efficiency developed at modern concentrating mills, can be treated at a good profit. It has, therefore, definitely been determined that much of this can, and will, be sent to the mill.
>
> Without going into too much detail, the net result is that instead of 55,000,000 tons of ore, averaging 2¼ per cent it is now estimated that there have been developed at the Chino property no less than 90,000,000 tons, averaging 1.83 per cent. This is the quantity of ore that will eventually be mined and milled from the areas originally developed.

In other words, where it was formerly the plan to say how much "fully developed, probable and possible ore" was available, together with the copper contents of each class, they now simply add to the total figures estimating fully developed ore by reducing the grade to any convenient average. In this way the "fully developed area" may be extended to the limits of a company's acreage, while no loop-hole will be left through which to question the particular value or lack of value of the added ground. The way this information concerning Chino is being exploited carries a conviction that the time is near at hand when a new bond and convertible stock issue, "for the purpose of enlarging the milling capacity," will be announced. This is further indicated in the following paragraph, taken from the article quoted from:

> The fifth section of the mill has been put into commission and there should be no difficulty in the mine's working up to the full mill requirements by the first [illegible] of the new year.

The only trouble about this report concerning what the mill is doing is that it does not seem to be true. In a dispatch from Silver City, N. M., to the El Paso Herald, dealing with Chino affairs and dated Nov. 21, we find this: "TWO SECTIONS of the big concentrator at Hurley are kept busy. LACK OF WATER prevents the concentrator from being run to its full capacity." It is up to investors who are being educated to believe that Chino is conducted on the square to reconcile these statements and weigh the methods used to add millions of tons to ore reserves.

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WANT THE COUNTY TO PAY

The expected has happened with respect to one feature of the Bingham strike. The Utah Copper Company which, on the 15th of October, was reported to have had no less than 525 "fighting deputy sheriffs" on its pay roll at $5 per day "and found," and which still probably has about 300 armed "deputies" prowling around looking for Union ghosts which seem to be frightening the wits out of its managers, has secured the signatures of some of the other Bingham companies and presented a petition to the county commissioners demanding that these armed deputies be paid by the county.

When these men were hired to "strike terror to the hearts" of the dissatisfied miners a general election was soon to be held and the governor, the sheriff and county commissioners—being candidates for reelection—without figuring on anything else, knew it would be suicidal to the Republican ticket to involve the county in any such expense as the employment of this needless army of "gun fighters" would entail and, following several conferences between officials of the county—including the governor—and the mine managers, the statement was given the broadest publicty that while the sheriff would recognize the army as deputy sheriffs by "swearing them in," they would receive their pay from the mining companies using them.

The election is over, the Republicans have won, and now the companies are tring to saddle the tremendous and altogether uncalled-for expense of the "deputy" payroll on to Salt Lake county. The county commissioners have decided to "stand pat" and have denied the petition, but of course the companies will not take this "no" for answer. The matter will come up again in some guise or another. Taxpayers should watch the game.

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The "low grade" porphyry reporters, under direction of their ringmasters, are now spreading out the big hay mattress to catch the high tumblers who vaulted from "the survival of the fittest" springboard something over three years ago. For additional particulars read the "merger" dope now being ladled out.

SMOKE AND NOXIOUS FUMES RETARD GROWTH OF SALT LAKE

NOTE.—The following article dealing with the deplorable smoke and noxious fume nuisance with which this city has to contend was in type and the proofs had been read on the 13th of the present month. Two days later one of the morning papers—seemingly inspired, and as if by revelation—"rose to the occasion" and waded into the smoke problem on its own account. The feature of its first article is found in the untenable premises taken on which to make its campaign and the intention since displayed to make the matter a question of petty politics, thus defeating any legitimate purpose that its labored efforts might otherwise have produced. The particular feature referred to in the first article was the haste with which the paper dismissed as immaterial the part played by the valley smelting works, in this fashion: "Our dry atmosphere offers easy escape for the volumes of soot; such immense smelting plants as might pollute the heavens are so far removed from the city that they need not enter into the equation." The motive for injecting that assertion into the daily paper's introductory remarks may possibly be discovered while reading the following presentation of the subject:

While it may seem a little out of place for a semi-technical mining publication like Mines and Methods to take up a subject such as is outlined in the title of this article, every progressive and home-loving resident of this city must agree with us that the diversion, if such it may be designated is fully justified by the atmospheric conditions under which (and in which) the good people here are compelled to struggle for freedom from the pall of poisonous filth which overhangs this naturally beautiful valley every day in the year that the atmosphere is not temporarily clarified by wind storms. False ideas of commercial exigency, manufacturing growth and civic pride seem to have had a paralyzing effect on the newspapers and the organizations who have been dealing with the subject for a long time (until a few days ago and mysteriously co-incident with the placing of this article in types and nothing has been accomplished.

About the first of the present month the chief of police and chief of the fire department reported that smoke conditions in the city were much improved. The very morning that that report was made in the papers a photographer might have gone out on the hills either to the north or east of the city and taken a picture that would have shown the city entirely submerged in a heavy, fog-like mantle through which nothing but the tops of the highest buildings could be seen. People coming from outside localities to the business district were attacked with fits of sneezing, coughing and other evidences of distress, including a stinging, burning sensation in the eyes, nostrils and throat, while the faces and [illegible] of tender-skinned individuals [illegible] tingled.

Down-town residents become accustomed to this and think little of it; but the strangers in town—the very class of people that we would have settle and make their homes here and those who talk about us and the conditions prevailing here when they leave—suffer more than we do from the conditions mentioned and consequently are unfavorably impressed. That first, unfavorable impression hurts the town—hurts its growth and hurts its business to a degree that evidently is not half understood or appreciated by the community at large, nor by those most interested from a business standpoint in seeing every condition tending to material advancement improved

WHERE WE DECEIVE.

The assurance is usually given outsiders that this condition is not a permanent one; that it is only on rare occasions—a few days in the year—that our so-called smoke nuisance is manifest. But our Commercial club, real estate association, medical fraternity, civic improvement societies, "city beautiful" clubs and all other classes of residents, fully realize that such statements are mere subterfuges and not in keeping with the truth; so that, if anything of real, tangible benefit is to be accomplished, we must first cease trying to deceive ourselves and the outside world and eradicate the evil.

Thousands of dollars are annually expended in publicity campaigns having for their purpose the advertising of Salt Lake as a natural and magnificently endowed health-building sanitarium. In the abstract this is true. We have a most

This picture was taken from a point within [illegible] of the Keith block on the afternoon of the 13th of this month. The view is toward the east, the finest residential section of Salt Lake. It was impossible for the camera's eye to penetrate this pall of smoke, but the fumes and gases [illegible] block except to the south, where the atmosphere [illegible] sufficiently to show a dim sketch of [illegible]. See [illegible] for a protest against the [illegible]

beautiful valley here, almost surrounded by majestic mountains. These are cut with deep canyons through which flow streams of sparkling, pure water. Uncontaminated this water is made to supply the city which, by rights of location and natural environment, should and could be made to cause every visitor to become an unsolicited champion of its merits as a place in which to live. We have springs of hot sulphur water and splendid bathing establishments therewith connected; we have, only a few minutes' ride from the city, the most famous body of salt water in the world, with its great resort and bathing facilities; we have mountain resorts and trout streams, sylvian lakes amid the woods and crags at elevations of thousands of feet above the Salt Lake basin, where those so inclined may go by motor car or train within an hour and escape the summer heat; in fact, we have everything required to make this city and valley a little Paradise on earth, WITH JUST ONE DRAWBACK that should not be tolerated for a longer period than is necessary to remove it for good, and that is the smoke and fume nuisance.

ROOT OF THE EVIL.

Years and years ago city ordinances were promulgated that were designed to eradicate the smoke nuisance and there was a general movement by the operators of steam-generating plants manufacturing establishments, public buildings, etc., to meet the requirements of the law. More and more attention has been given to the enforcement of these ordinances as the years have passed, but the seat of the difficulty—the root of the evil—has not been reached. The storekeepers, the good housewives all over the city, and particularly those having the direction and care of the finer homes, all know what it is to have delicate draperies and window hangings blackened and smudged at every attempt to throw the house open for airing. It has been learned that not only does the soot and dirt make its presence known by the discolorations produced, but that the damage does not stop there—the difficulty cuts deeper.

The soot and other more or less solid particles that make up the visible murkiness of the atmosphere is found to have absorbed and assimilated the sulphurous, arsenical fumes and gases that are discharged into the air in tremendous volume by the smelters on the margins of the city to the south. These fumes and gases are brought in by the air currents when they are moving from the south and their insidious work is detected not only in the ruin of delicate fabrics in the homes whenever cleansing is attempted, but their effect is plainly marked by the distress of the aged, feeble, sick and delicate people who find increasing difficulty in escaping the injurious effects of breathing these noxious substances, particularly if already suffering with bronchial and nasal afflictions. Physicians universally declare that the chemical combinations produced by the admixture of the substances complained of are most harmful and productive of various diseases, but with all this the most severe censure one hears is that this or that owner of some building has failed to comply with the ordinances requiring that devices be installed to make better the combustion of coal consumed in the heating or steam-generating plants connected therewith.

REMEDY? MOVE SMELTERS.

Viewed from different standpoints it appears that one of two things will have to be done: The people here will either have to work with a set determination of making this a magnificent city of homes, already famous for its climate and other advantages (some of which have been enumerated above), or they must yield to another viewpoint and allow the city to grow into a second Pittsburg—a smelter town. Which will be best, which do we want? are the matters to be decided; and that once settled, it is up to us to apply the remedy that will brings results. There is no middle ground. What shall we do?

The day is rapidly approaching when the plants to the south of town—as a result of depreciation and disintegration, coupled with the newer ideas and processes employed in the reduction of ores—will be compelled to reconstruct their works, anyhow. When that time comes (if the disposition is to exercise patience) urge or compel, if necessary, the owners to move out of this valley and go where no harm can result from operation. There is a world of room in the Rush Valley section, on the line of the San Pedro railroad, between Stockton and Tintic, where smoke and fumes could be turned loose without damage and where the interests of the few settlers could be acquired for a song.

To build new works in that section while the present plants are still in operation would prevent any loss of time to the smelting companies and give them a field in which no trouble would occur in the future. The location would bring them closer to many of the mines they serve and railroad facilities from all points could be made, with little trouble, and practically no additional cost to the shipper, just as good as they are in this valley. That this argument is sound is illustrated in the fact that the International Smelting Company is now operating in a section close to the one proposed for the valley smelters and on the same line of railroad, while it is doing business with mining companies operating all over Utah and in practically all of the surrounding states, from Arizona to Montana and from Colorado to California. What the International company is doing other companies can do and should be compelled to do.

The greatest trouble in carrying out measures of public policy and civic concern is usually found in the clashing of business interests. Avarice holds sway in one quarter; fear of huge corporation power begets a cringing, weak-kneed silence in another, while politicians and administrators of public affairs usually are too busy "fence building" to work zealously for the public weal. However, there is no reason why the presumbably untrammeled press should not speak up and let the people know that a campaign for the complete eradication of the ill-health-breeding nuisance will be supported. If it is found, as it will be, that so long as the big smelters are permitted to do business at the doors of the city the trouble will continue and grow worse instead of better, then the smelters must be persuaded to move—and this will not be asking too much, nor will it work such a hardship on the smelting companies as would appear at first thought.

MEANS MUCH TO CITY.

Such a move as that here proposed would mean a tremendous growth to Salt Lake City and Salt Lake valley. The city would still remain the principal supply point to the smelter communities and the chief offices would remain here. The lands abandoned by the smelters would at once become valuable for home-building and home-making purposes and a thrifty, permanent population would quickly replace the more or less shiftless class from which a large percentage of smelter workmen is recruited. That would mean increased business for the merchants of this city, which could then be advertised as the finest residence valley in the entire western country—and the claim would hold good.

If our public officials and business men shudder at the thought of inaugurating a move that evidently must be made sooner or later, what is the matter with having the women folks of the community formulate a petition embodying measures of relief to the incoming legislature and then insist on the Salt Lake county delegation working for it? Certainly it would not be opposed by senators and assemblymen from other portions of the state.

In anticipation of the probable and only defense that may be set up against the drastic measures here suggested, it may be said that the United States and American Smelting companies have installed a system of smoke filters known as the bag house process, whereby it is claimed

that the deleterious substances contained in the smelter fumes have been entirely neutralized or eliminated In answer to this, it is well known by every engineer, every chemist and metallurgist, as well as the farmer informed upon the subject, that the sole effect of the process has been to extract from the vaporous fumes the solid substances which, of themselves, are comparatively harmless, leaving in the air all of the more volatile sulphur and arsenic gases to mingle with and render unbearable and dangerous the otherwise comparatively harmless soot and smoke that is emitted from the furnaces of homes, business blocks factories and work shops.

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TOM LAWSON AT IT AGAIN

Are you reading Tom Lawson's articles in Everybody's, wherein he charges that the high cost of living is due to the robbery of the people by the stock gambling manipulators of Wall Street? If not, you ought to be. In the December issue he gives some history that will make a lot of wiseacres sit up and take notice and he also offers what he believes would be an effectual remedy for the evil. Incidentally he refers to the manner in which he helped the Guggenheims to unload a raft of Yukon Gold shares on the public and cleaned up $2,000,000 on the deal; how he got sand-bagged by his employes before he got through, and how later the stars of Financialdom, during the 1907 panic, begged him to get into harness and help them out of a hole; how he cleaned up another $2,000,000 on that job and how, some time later, he whisked the market for $6,000,000 in Chino. He promises to give details concerning the Chino deal when he gets around to it, and this promise will not tend to elate the manipulators who would now have you believe that the stock is worth $60 a share. Lawson is conceded—even by his enemies—to be a pretty bright fellow and on to all the tricks of the stock-gambling game, so you must not believe that he would have unloaded his Chino at prices made by himself for the occasion, if he did not know that he could not "stay in" and win—if he was not then certain that no "outsider" would ever be allowed to make money in that stock. Read what Thomas has to say and then try and figure out where you will land if you tackle Chino, Utah Copper and Ray Con., which are now being groomed for the day when the market can be forced and the public can be led into the slaughter house.

IMPORTANT RULING RESPECTING PHOSPHATES

All present owners of phosphate mining claims throughout the public domain and all those who in any way are interested in the search for, or who contemplate the purchase of phosphate deposits located upon the public lands, will feel relieved to learn that the Department of the Interior has fully passed upon the character of these deposits and pronounced them subject to disposition only under the provisions of the lode mining laws. Ever since the discovery of phosphate upon the public lands of the West there has been litigation between lode and placer claimants and in many instances this litigation has been bitterly contested and very expensive.

This decision of the Department of the Interior not only will clear up many cases within the phosphate reserve, but will act as an incentive to prospecting for further deposits upon the public domain outside of the specifically withdrawn areas. The Department's ruling, which is in the nature of instructions to the Commissioner of the General Land Office here, is dated Dec. 7, 1912, and reads as follows:

TEXT OF OPINION.

The Department is in receipt of your letter of February 19, 1912, submitting for instructions, pursuant to departmental order of June 30, 1910, the matter of mineral entry 01635, made August 31, 1909, for the Harry Lode mining claim, situated in the E ½, Sec. 7; W. ½, Sec. 8, T. 11 N., R. 8 E., S. L. B. M., Salt Lake City, Utah.

This claim was located October 31, 1907, by M. S. Duffield, et al., the present entrymen, on account of a deposit of rock phosphate disclosed therein. Subsequently to such location and on December 9, 1908, the township wherein the claim is situated was, by departmental order of that date, withdrawn from all forms of location and disposal, subject, however, to valid existing rights. By executive order of July 1, 1910, the said departmental order of withdrawal was, insofar as it included lands described in said executive order ratified, confirmed, and continued in full force and effect; and subject to all of the provisions, limitations, exceptions and conditions contained in the act of Congress entitled "An Act to authorize the President of the United States to make withdrawals of public lands on certain cases," approved June 25, 1910, there is hereby withdrawn from settlement, location, sale or entry and reserved for classification and in aid of legislation affecting the use and disposal of the phosphate lands belonging to the United States, all those certain lands of the United States set forth and particularly described as follows, to-wit: T. 11 N., R. 8 E., Secs. 4 to 9 and 16 to 21, inclusive; Secs. 30 and 31.

You report that: "The application proceedings appear to be regular in all respects, the only question in the case being as to the patentability of the land; and, if patentable, whether as a lode claim, as applied for and entered, or under the laws pertaining to placer mining claims."

In the case of Henderson, et al., vs. Fulton (35 L. D., 652, 662), it is said: "It may well be further stated, as a proposition equally supported by the authorities, that the amount of land which may be located as a vein or lode claim and the amount which may be located as a placer claim, and the price per acre required to be paid to the Government in the two cases when patents are obtained, and the rights conferred by the respective locations and patents, and the conditions upon which such rights are held, differ so materially as to make the question whether mineral lands claimed in any given case belong to one class or to the other, a matter of importance both to the Government and to the mining claimant. And, it is also true, mineral lands of either class can not be lawfully located and patented except under the provisions of the statute applicable to such class. Veins or lodes may be located and patented only under the law applicable to veins or lodes. Deposits other than veins or lodes are subject to location and patent only under the law applicable to placer claims."

And at page 685 of the same decision, it is said: "It is apparent also that Congress had in mind and fully recognized, what experience had heretofore abundantly shown, that these two classes of mineral deposits are so different in their character and formation, and so completely separate and distinct from each other, that even when found to exist in the same superficial area, they may be located and held by different persons, and patented accordingly (Sec. 2333). This principle has been recognized and followed in both judicial and departmental decisions (Reynolds v. Iron Silver Mining Company, 116 U. S., 687, 695-7; Aurora Lode vs. Bulger Hill and Nugget Gulch Placer, 23 L. D., 95, 99-100; Daphne Lode Claim, 32 L. D., 513; Jaw Bone Lode v. Damon Placer, 54 L. D., 72)."

To the same effect also is the decision

in E. M. Palmer (38 L. D., 294). See also Clipper Mining Company v. Eli. Mining and Land Company (194 U. S., 220, 228) and Webb v. American Asphaltum Mining Company (157 Fed. Rep., 263, 266).

If, therefore, the deposit, on account of which title to the claim here in question is sought, exists therein in vein or lode formation, the area would be disposable only under the provisions of the lode mining laws. If, on the other hand, it be a placer deposit and there be no lode within the limits of the claim, the lode laws would have no application, but the land would be subject to entry and patent exclusively under the provisions of the placer mining laws.

The claim is situated in the northern part of what is known as the Crawford Mountain area. The record in this particular case does not present such a description of the deposit as would enable the Department to intelligently determine its precise character. The claim, however, is shown to adjoin, on its northerly end, the southerly end of the patented Lorine Lode mining claim, and to be laid along a southerly extension of the outcrop of the same deposit, which, in a report filed in connection with the Lorine patent proceeding, was described by the mineral surveyor, who surveyed the latter claim. This description, which is deemed by the Department to sufficiently establish the character of the deposit disclosed on this claim, is as follows: "The said deposit consists of a series of bedded veins of rock containing varying proportions of calcic phosphate. The individual veins of the series of veins vary in thickness from a few inches to ten or twelve feet. Only a portion of the veins contain rock sufficiently rich in calcic phosphate to be of commercial value, and only a portion of the veins are thick enough to be profitably mined, even when the contained proportion of calcic phosphate is sufficiently high.

Physically, the higher grade vein rock occurring in the veins of the Lorine lode location is hard, its color is a grayish, bluish black. It is homogeneous in appearance, and is composed of small oolitic rounded grains cemented together by an extremely thin film of calcite and silica. Taken as a whole, the above mentioned series of beded veins of phosphate rock and also each of the individual or separate veins of the series lies between, is conformable to, and is bounded by walls of rock, which wall rock is generally limestone, but often is a very silicious or cherty limestone, or a soft sandstone, or a shale or quartzite."

Here follows a sectional description of the phosphate beds disclosed in the tunnel on the claim.

From the position of the hanging wall of the series of veins as exposed in the Lorine tunnel, the indications on the surface along the apex of the veins and the prominently outcropping foot wall formation west of the mouth of the Lorine tunnel, I estimate the thickness of the series of veins, taken as a whole, from the contact of the eastern-most vein of the series of veins with its hanging wall, to the contact of the western-most vein of the series with its foot wall, to be approximately 110 ft.

As shown in the above descriptions, the individual veins of the series of veins of phosphate rock which exist in the Lorine location, are separated from each other by strata of limestone, chert or shale. These separating strata vary in thickness from less than an inch to several feet. Taken as a whole, the series of veins lies between and is clearly limited and defined in extent and position by solid massive walls of hard silicious, limestone. Within the series of veins the separating strata limit and define the extent and position of the corresponding individual veins of the series and are the walls of these individual veins. The strike and dip of the veins and walls conform to each other throughout their entire extent within the Lorine lode location. I thus find that, taken separately or as a series, that is, as a whole, the veins are obviously in place between walls, have a well defined dip, and strike and are an essential part of the mountain upon which the Lorine lode location is located.

This and co-related deposits in Bear Lake county, Idaho; Uintah county, Wyoming, and Rich, Weber and Morgan counties, Utah, were in 1909 examined by Messrs. Hoyt S. Gale and Ralph W. Richards, geologists of the United States Geological Survey, the results of which examination are given in Bulletin No. 430. As described by those gentlemen, the formations and the phosphate-bearing member thereof do not differ in any substantial particular from the formations and deposit existing upon the Lorine claim described by the mineral surveyor thereof.

Sections 2320 to 2328 of the Revised Statutes make certain provisions for the locating, working, holding and purchase of mining claims "upon veins or lodes or quartz or other rock in place, bearing gold, silver, cinnabar, lead, tin, copper, or other valuable deposits." Sections 2329 to 2331 provide that claims usually called "placer," including all forms of deposit excepting veins of quartz, or other rock in place, shall be subject to entry and patent under like circumstances and conditions and upon similar proceedings, as are provided for vein or lode claims, but with wholly different provisions as to extralateral rights, area, survey, and price to be paid for the land.

If, therefore, the deposit here in question, which undoubtedly contains a valuable mineral substance, answers the description of a vein or lode of quartz or other rock in place, it is subject to disposition exclusively under the provisions of the lode land law. If not, then the placer laws alone are operative.

In the case of Iron Silver Mining Company v. Cheesman (116 U. S., 529., the Supreme Court, page 533, said: "What constitutes a lode or vein of mineral matter has been no easy thing to define. In this court no clear definition has been given. On the circuit it has often been attempted. Mr. Justice Field, in the Eureka case (4 Sawyer, 302, 311), shows that the word is not always used in the same sense by scientific works on geology and mineralogy and by those engaged in the actual working of mines."

After setting forth the court's definition in the Eureka case, the court says: "This definition has received repeated commendation in other cases, especially in Stevens v. Williams (1 McCrary 480, 488), where a shorter definition by Judge Hallett of the Colorado Circuit Court, is also approved, to-wit: 'In general, it may be said, that a lode or vein is a body of mineral or mineral body of rock, within defined boundaries, in the general mass of the mountain.'"

In Hays, et al., v. Lavagnino (53 Pac., 1029), is is held (Syllabus) that: "In practical mining, the terms 'vein' and 'lode' apply to all deposits of mineralized matter within any zone or belt of mineralized rock separated from the neighboring rock by well-defined boundaries and the discoverer of such a deposit may locate it as a vein or lode. In this sense, these terms were employed in the several acts of Congress relating to mining location."

In Beale v. Cone (62 Pac., 948, 953), it is said: "The controlling characteristic of a vein is a continuous body of mineral-bearing rock in place, in the general mass of the surrounding formation. If it possess these requisites and carry mineral in appreciable quantities, it is a mineral-bearing vein within the meaning of the law, even though its boundaries may not have been ascertained."

In the case of the United States Mining Company v. Lawson (134 Fed. Rep., 769), which was affirmed by the Supreme Court (207 U. S., 1), it was held that a broken, altered, and mineralized zone of limestone, lying between walls of quartzite constituted a lode or vein within the meaning of the mining laws.

In Duggan v. David (28 N. W., 887), a deposit of mineralized quartzite, a formation of purely sedimentary origin,

about ten feet in thickness, inclosed between a stratum of limestone and a separate and distinct bed of quartzite, and having a dip of about 8 deg., was regarded by the court as a lode or vein within the meaning of the mining laws.

In the case of E. M. Palmer, supra, the Department has before it for determination the question as to whether a deposit of sandstone shown to carry gold, which had been located under the placer mining laws, was a lode or placer formation. The Department, in that case, at page 297, said: "From the reasoning of the authorities cited, it follows that sandrock or sedimentary sandstone formation in the general mass of the mountain-bearing gold, such as is here disclosed by the evidence, is rock in place bearing mineral and constitutes a vein or lode, within the purview of the statute, and can be located and entered only under the law applicable to lode deposits. The Department is convinced that the deposit described in the testimony in this case falls well within the category of lode deposits under the mining statutes, and that such a deposit can not lawfully be appropriated or patented under those portions of the statutes which apply to placer claims."

The mineral-bearing sedimentary deposits, held in the cases above cited to be lodes or veins within the meaning of the mining laws, were valuable on account of the metallic minerals therein contained. In Webb v. American Asphaltum Mining Company, supra, decided in 1907, it was, however, held, in substance, that the clause other valuable deposits," used in section 2320, Revised Statutes, includes non-metaliferous as well as metaliferous deposits, and hence that a deposit of asphaltum in lodes or veins in rock in place may be entered and patented under section 2320, and may not be secured by means of placer claims under section 2329, nor the act of February 11, 1897 (29 Stat., 526) regarding the entry of lands containing petroleum and other mineral oils. Citing and following this decision, the Department, in the case of Utah Onyx Development Company (38 L. D., 504), held that valuable deposits of onyx occurring in well-defined fissures, with clearly marked hanging and foot walls of limestone, are subject to appropriation only under the lode mining laws. In the earlier case of Henderson et al., v. Fulton, supra, the Department said, at page 683: "Some of the authorities hold the view that only minerals of the metallic class are within the statutes relating to veins or lodes, but the great weight of authority is the other way; and the Department is of the opinion that the latter is the better view. That the statute is broad enough to embrace minerals of the non-metallic as well as the metallic class, wherever found in rock in place, was distinctly held after careful consideration and full discussion in the case of Pacific Coast Marble Company v. Northern Pacific Railroad Company (25 L. D., 233, 241, 243). See also Lindley on Mines, Secs. 86, 323; 1 Snyder on Mines, Sec. 337)."

It is immaterial, therefore, whether a deposit bear minerals of a metallic or non-metallic nature; if a mineral deposit exist in vein or lode formation—that is to say, if it be in place in the general mass of the mountain—it is, whether the mineral it bears be metallic or non-metallic, subject to disposition only under the provisions of the lode mining laws.

From the foregoing, it is clear to the Department that a deposit of phosphate rock, such as that herein-above described, confined, as it is shown to be, between well defined boundaries, constitutes a lode or vein of mineral bearing rock in place within the general mass of the mountain, and hence is subject to disposition only under the provisions of the lode mining laws.

This location, so far as the record discloses, was made in entire good faith, and there is no suggestion of anything that might in any wise invalidate the claim, the location, and, in fact, the entry, having been made before the executive withdrawal of July 1, 1910.

In the absence of other objection, therefore, the claim will be passed to patent as located and entered.

Very respectfully,

SAMUEL ADAMS,
First Assist. Sec'y.

EXTRACTING GOLD FROM GRAVEL DEPOSITS [II.]

By AL H. MARTIN.

The hydraulic mining process is sixty years old; 1852 saw the first application of the principle, and the modern "giant" was an established reality in 1886. Since that time a few minor improvements have been made, but the device is practically the same as when Craig invented it, one years after the close of the civil war. Like the modern stamp mill, hydraulic mining first saw the light in California. Its development followed a period of evolution; its perfection was the fruit of years of practice with cruder appliances. In the gold rush to California in 1849 and 1850, miners from all corners of the world poured into the new El Dorado. Each nation contributed its favorite contrivance for the winning of the gold from the placers. The Mexican and the Chilean brought the batea—and the southeastern Americans brought the rocker. At this period the Georgians were the most skillful and enterprising of American gold miners. The hills and ravines of sunny Georgia yielded much of America's gold, and it was fitting that the gallant Southerners should play a stellar part in the mining of the treasures of a new state they had so valiantly struggled to add to the national constellation As the surface deposits became exhausted it naturally developed that more advanced methods were employed to win the auriferous wealth. The long-tom followed the rocker, and in its steps treaded the sluice box. By 1852 sluice mining had advanced to the point where operations were conducted by running a stream of water on a gravel bank, washing down the waste to the pay-gravel, and then leading the auriferous material into sluices by pick and shovel. The method naturally consumed much time and costly labor, and many of the more progressive operators demanded more effective means.

FIRST HYDRAULIC MONITOR.

And necessity compelled the remedy. Two camps claim the honor as the birthplace of hydraulic mining, but to Nevada City history awards the palm. The name of the pioneer inventor has been forgotten, but his device survives. A bank of deep gravel, averaging about fifteen feet, invited operations and it was evident that more advanced methods than those prevailing must be employed to compel greatest success. The enterprising miner procured a quantity of green beef hides, of which he formed a hose with the aid of copper rivets. For the nozzle he took two pieces of wood, hollowed them out and fastened them securely with hoops of iron to the hide hose. News of the novel attempt spread fast and a crowd of interested, half-skeptical gold-diggers, were on had to witness the first trial. At the first shock of water the gravel bank commenced to crumble, and soon the mass of material was crashing down to the sluices The hydraulic monitor had been born!

About the same time the device was used near Forest Hill, Placer county, and was soon in general use throughout the foothills. The hides were soon replaced with heavy canvas, and copper shanks and nozzles used. The average hose had a diameter of six inches, with the nozzles having diameters varying

from one to three inches. As more difficult gravel was mined, and heavier streams of water were employed, the first hose was covered with a second of particularly heavy canvas, and the whole protected with heavy rope netting. This method prevailed until heavier work resulted in the employment of sheet-iron ferules to prevent the breaking of the hose.

From the first no difficulty was experienced in breaking down the gravel banks with the crushing jets of water—the problem was to construct a hose of sufficient strength to withstand the terrific strain. The question was answered by substituting seven-inch galvanized pipe for the hose, with a short piece of strong hose attached to the nozzle to provide flexibility. Then came the so-called "goose-neck," facilitating the revolution of the nozzle in a circle, and in 1866 Craig perfected the modern giant.

STAGGERING PRODUCTION FIGURES.

With hydraulic mining in full swing, California maintained a steady production of $20,000,000 to $30,000,000 per annum. From the discoveries of 1849 to 1883, California gravels yielded the stupendous total of $1,050,000,000. The zenith was reached in 1852 when $81,294,700 was produced. And several years recorded from $50,000,000 to $75,000,000, eloquently testifying to the marvelous wealth of the deposits. The enactment of anti-debris legislation struck down the industry in its prime, but while the giant has passed from the majority of California districts, the state has played the greatest role in the development of one of the most effective and inexpensive mining methods ever devised for extraction of gold from auriferous deposits.

To employ the hydraulic method to best advantage, water must be plentiful, and a convenient dumping ground is imperative. It is usually requisite that large reservoirs be provided for conservation of water for the dry season, otherwise the operator will probably find his water lacking when most desired. This is particularly true of the Western states of America, where the year is divided into wet and dry seasons. Magnitude of installation depends on extent and values of ground, and the same care is required in providing equipment and arranging for the scale of operations, as pertains to other branches of mining. The engineer must be largely influenced by the status of the property and local conditions. The low operating costs and the vast quantity of material handled in a given time form two of the most important factors in favor of the method.

NOTABLE OPERATING EXAMPLES

The most noted, and probably the largest, of the world's active hydraulic mines, is the famous La Grange, at Weaverville, in the north-western portion of California. The laws militating against hydraulic mining in California are not effective in Trinity, Siskiyou, Humboldt and Del Norte counties, as the streams drain directly into the Pacific ocean. In the central and valley sections, the streams are tributary to either the Sacramento or San Joaquin rivers, the two principal watercourses of the state. The lands lying along those rivers are generally low, and the laws against the hydraulic operators were largely enforced because of allegations that deposition of debris in the streams caused disastrous floods in the lowlands. In the counties specified the lands bordering the streams are generally high, consequently there is no danger of inundations in the rainy season. As a result, hydraulic mining flourishes in these districts, particularly in Trinity and Siskiyou, with much of its primeval glory. La Grange for years has been the leading hydraulic property in the state, and the methods employed mark the culmination of the most advanced hydraulic practice.

The deposit is geologically a portion of an ancient channel formed by the Trinity river and its branches. The channel has a width of approximately one mile, and in places attains a depth of 60 feet. The bedrock is of rough, slaty structure, with a bed of sticky clay dividing it from the north belt of gray schistose rock. The gravel contains considerable rough rock and huge boulders, with a heavy deposit of cemented material occurring in the lower portion of the channel. The ground offers considerable difficulty to mining, and the ease with which the company has mastered all problems is an eminent testimonial to the efficacy of hydraulicking intelligently applied.

The water supply is developed on Stewart's Fork of the Trinity river, twenty-nine miles from the mine. Over eight miles of flume brings the water from the reservoir to the first inverted siphon. The mammoth pipe has a 4,800-foot span, with a depression of 1100 feet, and is composed of 30-inch steel pipe, with the lower portion a half-inch thick. From this siphon the water passes through a 9000-foot tunnel, two smaller siphons, a flume and a ditch, to the supply reservoir at the penstock. The maximum flow is 3400 miner's inches. Three main pipelines command the penstock and supplies water to six giants operating under 450 to 650 feet head pressure. Three of these big monitors, together with one smaller, operate simultaneously. The largest pipes have 30-inch diameters, with 15 to 18-inch in-takes and discharging through nozzles ranging from five to eight inches. Guage of pipe ranges from No. 4 to No. 7. Each giant is provided with safety-clutches, to prevent accidents to operators, should the kingbolt snap and the huge head of the machine hurl into space. The pipes are also fitted with devices permitting the operator to ride the pipe and deflect the stream to any point with ease and efficiency. The safety devices were invented by Manager Pierre Bouery, and have frequently proven their value. Automatic floats regulate the reservoir discharge, consequently a uniform quantity of water is constantly delivered, whether the reservoir is nearly empty or full, regardless of pressure. Operations are carried on day and night, the property being excellently illuminated with electric lights; imprinting a striking and lasting scene on the mind of the observer as the huge streams of water sparkle and shine under the glare of the globes.

HOW THE WORK IS DONE.

The 600-foot bank is generally undercut by the jets of water and slowly crumbling, breaks down the stubborn cemented deposit with its terrible weight. Formerly blasting was resorted to for the disintegration of the cemented gravel, but this is now employed only for the breaking of mammoth boulders and the masses of cemented material that are not reduced sufficiently by the caving of the upper bank. The belts of clay are bored with an Ingersoll wood-boring machine and blasted. Derricks are used to remove the boulders, this being done while the giants are operating on some other portion of the mine. The bedrock is swept clean by the searching water, and no scraping is required.

The sluice has an approximate length of 3000 feet, with the sluice-boxes four by six feet in cross-sections, set into the bedrock. With the exception of the first seventy which have a slope of seven inches per twelve feet, the boxes are inclined to a grade of eight inches per twelve feet. Steel rails are used for lining throughout. With the exception of a few longitudinal rails in the first few boxes, designed to aid the flow of material, the rails are laid transversely. A space of five inches between rails is generally employed. Thirty transverse rails are placed in each of the 150 boxes. The powerful stream drives 1000 cubic yards of material through the sluice-way per hour, including boulders weighing up to seven tons. At times blockades form, and the operating crew break the jams with iron bars. This work is attended with considerable danger, but accidents are rare among the skilled workers. At times the jam becomes so serious that sluicing is temporarily suspended, but this is of comparatively rare occurrence.

About 1400 feet from the head of the sluice is a steel door and branch sluices,

by means of which the material is diverted to other dumping grounds. This also facilitates the rapid clearing of the sluice when desired. Manganese steel is used in the riffles, and while the rails, including attached lugs, cost about $5 for each prepared six-foot section, their long life and general fitness for the work, justifies their employment. The high freight rate forms one of the main items of expense, all materials being shipped in from Redding by teams, a distance of about thirty-five miles. The lower sluices are cleaned up frequently, but the first fifty boxes are generally attended to only three times each year.

"ANTI-HYDRAULIC" METHODS.

An interesting example of a property operated under the anti-hydraulic laws is presented by the Brandy City mines, at Brandy, Sierra county, California. The channel ranges from 200 to 600 feet wide, with a depth exceeding 200 feet. Coarse gravel overlays the bedrock, and in turn is capped by a belt of fine gravel and clay or decomposed slate. Above this is a fifty-foot belt of lava and loose surface gravel. Adits, ranging from twenty to forty feet long, are driven under the lava bed, crosscuts extended, and the material blasted. The gravel near bedrock is a cemented type and requires blasting. The numerous boulders are blasted and removed by derricks. A flow of 4000 miner's inches of water is brought to the placers from Canyon creek, a distance of ten miles. Flumes are used for this purposes. Six giants are used, two being operated together. The sluices are provided with steel riffles in the first string of boxes, but in the lower section 18-inch wooden blocks are employed. Boxes have dimensions of five by five inches. The sluices discharge the debris into a canyon, across which the restraining dam is constructed. The barrier, built of masonry and concrete, has a thickness of twenty feet and is designed to prevent the escape of any tailings to the creeks. From the main line of sluices, a branch flume conducts the gravel to the barrier, constantly adding to its strength and height. By arrangement of the flume the gravel is regularly piled higer, and a compact rock wall thus provided. The greatest care is requisite in construction and maintenance of these dams, as the escape of even small percentages of debris is a direct violation of the regulations, and means the immediate closing of the property.

Before a property can be worked under the anti-debris laws, it is necessary that permission be solicited of the California Debris Commission, and due notice of the application is advertised and all protestants given an opportunity to record their disapproval. Barriers must always be of concrete or masonry, and pass the appoval of the proper officials. Several companies have literally complied with regulations, only to have their mines closed after a short productive period because of escape of small quantities of foreign matter with the water. The building of restraining dams forms a costly expense item, and the uncertainty of future operations militates heavily against the widespread application of the practice in affected districts. Formerly barriers of timber and brushwood were permitted, but this method later fell into disfavor with the anti-debris interests, and its use was prohibited.

As prevails at the La Grange mine, the Brandy City properties are electrically illuminated and operations are conducted day and night, provided sufficient water is available. Methods of operations are similar, and the two illustrations here cited give a good idea of the hydraulic mining principles as universally applied. When natural conditions are favorable the practice has many features to recommend it, but the restrictions fencing it round in sections dominated by anti-debris elements add so many elements of uncertainty, that the ground must be particularly attractive to justify the heavy initial expense, with a possibility that work will be prohibited before the initial clean-up can be made. Permission to operate does not imply that work cannot be stopped should excuse present.

Numerous California operators have learned this bitter truth from sad experience, and the same lesson has not been ignored in other fields similarly affected. In hydraulic mining the disposition of tailings often claims almost the same importance as the fume problem exacts from copper mining companies, and it is this factor that has banished the giant from California districts where the wealth of placer deposits still warrant zealous attention.

MONITOR-STACKING OF TAILINGS.

Occupying as it does such an important position, the disposal of the tailings forms a stellar link in the operation of the enterprise. Aside from the laws militating against him, the operator is often confronted with natural conditions of a complex character. The deposit may be situated at such a low point that the tailings must be elevated. Or, the dumping grounds may be so limited that the material cannot be stored in the ordinary way. In some of the California fields the elevator platform is employed. As the gravel giants tear down the banks, one or two other monitors drive the tailings up an inclined platform and the debris is dropped over the rear end. By running out braced timbers the length of the platform is constantly extended and the tailings easily piled. The objection to this method lies in the unwieldly nature of the device which must be moved from point to point as work progresses, involving expenditures of labor and time. The initial cost of such an arrangement, while comparatively small, is also a factor against its employment. But it has proven efficient in districts where the escape of foreign matter to the streams involved no consequence.

An effective method employed by some operators, where dumping facilities are restricted, but water is abundant, is stacking direct with giants. The mining giants are employed as usual, and at the discharge end of the sluiceway are stationed two or three monitors, their streams directed at right angles to the tailing issuing from the boxes. The heavier gravel is forced aside and gradually grows into piles resembling the tailings built up by the stacker of gold dredges. As the pile develops the monitor is gradually raised, and the succeeding gravel carried to top of pile. The giant is then lowered and another charge of tailings driven to the top. In this way all the coarse gravel is piled with a minimum of space consumed. The finer material is carried down the creek. In this method a large quantity of water is constantly required, and the fact that only the coarse material is prevented from flowing into creeks, precludes its use in districts governed by anti-hydraulic laws. But where conditions favor its employment, this process has much to recommend it.

It has been suggested that pumps might be employed to gather up the fine material and deposit it in restraining reservoirs, much as hydraulic dams are constructed in engineering projects. This method involves the hydraulicking of the banks in usual manner, with centrifugal pumps gathering up the mud and water and elevating it to desired points. This is the practice employed in the building of the Gratun dam on the Panama canal, and the San Fernando dam on the Los Angeles aqueduct, as well as numerous smaller enterprises of similar character. Four cubic yards of water are usually employed to each cubic yard of earth, and after depositing the material the water is returned for fresh duty.

To operate this system in conjunction with mining giants, a good supply of water is requisite, but with this feature favoring the method seems to offer some promise to companies prevented from operating because of escape of debris to navigable streams It is the fine material that has caused the trouble for hydraulic operators in practically every instance, as the coarse gravel is impounded and retained without difficulty. The efficiency of the process for the building of barriers to hold in leash billions of gallons of

water, indicates it would be likewise efficacious in preventing escape of foreign matter to navigable streams.

The expense of installation would form an important point for the engineer's consideration, as the suggested system demands the employment of large pumps, in addition to a supply system for the giants, pumps and gravity way for the return of water. At the San Fernando dam 200 to 250 cubic yards of material are deposited every hour with 300 miner's inches of water consumed per day, including the amount supplied to the giants. The water from the giants washes down the material and the whole is gathered up by pumps and the solid matter placed at desired points. The released water descends by gravity to the pipes delivering to giants, and the same stream is thus used over and over. In this way the water is conserved to the utmost point, and the cost of operation is largely cut down. The mode of operation is largely automatic, and it seems that this method might be practically employed in some instances, particularly where the escape of fine material is the principal factor militating against operations.

HYDRAULIC MINING FLOURISHES.

The present decade finds hydraulic mining flourishing most extensively in Alaska, Yukon Territory, British Columbia and favorable districts of California, Oregon and one or two other fields. In every instance a good supply of water is obtainable the greater portion of the year, while natural conditions have favored the prevalence of the practice. In numerous fields, however, where the giant was formerly deemed supreme, the gold dredge has usurped its throne, and this mode of mining is slowly ousting the monitor from some of its greatest strongholds. But dredge mining also has its limitations, and there are fields where the giant will always be operated as long as the placers contain sufficient reward.

It is one of the interesting possibilities of the future that hydraulic mining will be revived in the California districts lying along the foothills of the Sierra Nevada mountains. Engineers have long pointed out the feasibility of this, if the various owners would form a powerful syndicate for the deposition of the tailings on the waste and tule lands in the lower portion of the valley of the Sacramento river. This would eliminate the objections to hydraulicking in the vast majority of cases, and would also redeem thousands of acres of present worthless lowlands. The plan involves tremendous expenditures, but the end sought is declared by eminent engineers to justify the means.

HANDLING ACETYLENE

Owing to some recent accidents with acetylene burners, the French Minister of Commerce has submitted to a commission the question of precautions to be taken with the cylinders containing compressed gases (Journal du Four Electrique, Nov. 1, 1912). The following are the rules laid down: The cylinder containing compressed gases for autogenous welding, or for cutting metals, should not be used in workshops where there are floors above containing people. Before being placed in service each bottle should be placed in a ditch of which the sides are protected by battens of wood, and only the neck of the bottle should appear above the surface of the ground. The cylinder should be placed at least 5 m. from any fire. Each cylinder should bear legibly upon it the date of being placed in service, and the pressure to which it was submitted at the last test, and the date of the test. It is forbidden to employ any lubricating greases for greasing the valve, except glycerin or soapy water. It is equally forbidden to employ any heat to make it easier to open the valve, even though this opening proves to be difficult. In using oxyhydrogen gas for soldering there should always be a mixer between the bottles and the flame. There should be a distance of at least 3 m. between the neck of the flask and the neighborhood where the flame is to be used.

TEMPERATURE OF FLAMES

According to a lecture delivered by J. A. Harker, at the Royal Institution, London, the accompanying table gives the temperatures obtained in various forms of commercial apparatus:

Working Temperatures	Deg. C
Bunsen burner	1100—1350
Meker burner	1450—1500
Gasoline blast lamp	1500—1600
Large gas furnaces	1500—1800
Oxyhydrogen flame	about 2000
Oxyacetylene flame	about 2100
Thermit	about 2500
Electric arc	about 3500
Electric arc (under pressure)	about 3600
Sun	about 5500

Sulphuric acid when employed for the hardening of the cutting edge of drills should be poured to the depth of about an eighth of an inch in some vessel. The point of the drill is heated to a dull cherry red and dipped in the acid to that depth. This makes the point extremely hard while the rest remains soft. If the point breaks, reharden with a little less acid in the vessel. After hardening a drill in this manner, wipe off the acid, as if allowed to remain will destroy the cutting edge.

Compressed air that is to be used for aerating the sand or slime, or in agitating the pulp is purified by filtration before use at many cyanide plants. Several types of filters are used; at the Homestake plants the air is passed through a filter press made up of several cells similar in all respects to the cells of the Merrill presses used in the treatment of slime. Cylinder oil or the products of its combustion or decomposition, which are introduced into the air in the cylinders of the compressors, are the impurities that should be removed as completely as possible before the air is used for agitating. The apparatus at the Alaska Treadwell has a further advantage in that carbonic acid is also removed by caustic soda or milk of lime. The removal of this acid is accompanied by a decrease in the consumption of cyanide, for it is a well known fact that carbonic acid decomposes potassium and sodium cyanides, and even in the presence of an abundance of protective alkali some decomposition by this acid may take place.

In the old mining days, writes an engineer, timbermen had to come to surface and select their own timber and ride down in the skip with it. In one of the Copper Country mines there were two gangs of timbermen, one Cornish, the other German, and a great deal of rivalry existed. One day while the "Cousins" were sending down timber, two of the Germans rode down with the first load and at the second level the rope broke. A spectator seeing something was wrong called to the "Cousins" at the collar of the shaft: "What's wrong?" "Skip gone down without the string to it." "Any one in the skip?" "Yes, planks, wedges and two Dutchmen—planks and wedges belong to we."—Engineering and Mining Journal.

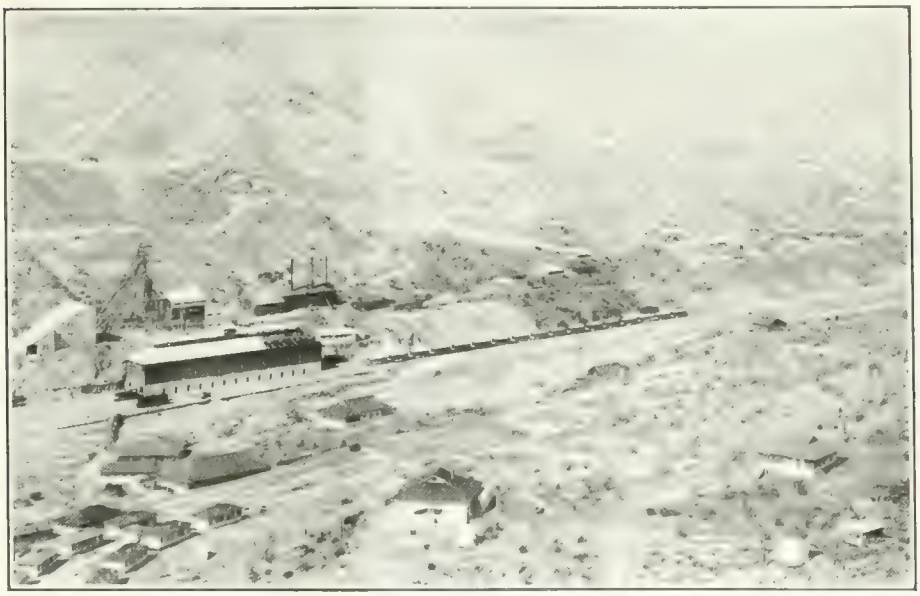
There has just been put out of service at the Dolcoath mine in Cornwall an engine which was erected in the year 1815. During all the intervening period it has been working faithfully and well and is a tribute alike to Cornish mechanical genius and workmanship. That it has now ceased to perform its functions is due in no sense to lack of duty or weariness in well-doing, but simply to the circumstance that the old at Dolcoath is giving place to the new.

High voltage machine terminals should have insulating covers or grounded metal covers. Unauthorized persons must not enter stations or transformer rooms. Fire buckets, filled with clean dry sand should be kept in these places for prompt use in extinguishing fires.

RAY CONSOLIDATED PROPERTIES; DESCRIPTION AND COMMENT

By JAS. O. CLIFFORD.*

The mining properties of the Ray Consolidated Copper company are at Ray, Pinal county, Arizona, about twenty miles west of the Globe district. The Ray & Gila Valley railway, a standard guage line owned by the company, connects Ray with the Arizona Eastern railway at Ray Junction, a station on the latter road about six miles south of the mines.



View of Ray Con. Mine at No. 1 Shaft.

The area of mineral land controlled by the Ray Consolidated Copper company in the Ray mining district is, approximately, 2,500 acres, nearly all of which is held under patent.

GEOLOGY OF DISTRICT.

The Ray, or Mineral Creek mining district, is an intermountain basin having an average elevation of approximately 2,300 feet, surrounded by peaks 3,500 to 6,500 feet high.

Geologically the Ray "disseminated" copper deposits differ from the several so-called "porphyries"—excepting the Miami-Inspiration properties, of which they are an exact counterpart—and, therefore, a general outline of the principal features of the district is herewith given:

The rocks of the district include diabase, granite, dacite, schists, quartzites, limestones, and conglomerate. The diabase is the oldest rock in the district, and apparently is of the same age as the diabase found at Globe and Miami. The freshly broken rock is dark-gray to black in color, and clearly shows feldspar crystals, and considerable augite and magnetite. The diabase occurs abundantly in the quartzite area a few miles east of Ray, where it has intruded along the shale beds, although also breaking irregularly across all horizons in the district. Three large diabase dikes occur in the mineralized area of Ray; one extending from the Ray Con. offices to the summit of Ray mountain, having a dip of 50 deg W.; a second runs west along a fault plane, and a third shows at the southeast end of Ray mountain. These dikes vary from two to 100 feet wide. The rock evidences decomposition by acid waters with attendant impregnation of small quartz veinlets. Generally the rock carries chalcopyrite and pyrite, and in some instances the dikes were worked as veins, the material mined having averaged as high as 10% copper. The diabase occuring in the Ray mines will average throughout from 0.50 to 1.0% copper. None of the dikes are, however, well exposed on the surface.

The granite at Ray occurs as intrusive bodies that are off-shoots of the great mass exposed to the west and southwest, and doubtless underlying the entire district at considerable depth. The rock exposed in the Ray Central and Ray Con. mines apparently cuts off the diabase dikes. The rock is an ore-carrier in these intrusive tongues. East of Mineral Creek there is an extensive mass of granite exposed which has cut through the quartzite and the schist. This mass shows comparatively little alteration, and is not an ore-carrier.

The dacite covers a large part of the district east of Mineral creek, and occurs as a capping on mountains to the north and west of it. In color it varies from pink to dark-lavender. This is the prevailing rock along the east side of Mineral creek, and forms high bluffs along the eastern mountain base. The greater part of the lower hill country between

Ray Consolidated Concentrator at Hayden.

*Mining and Metallurgical Engineer, Mills Building, El Paso, Texas.

the creek and the mountains eastward is covered by thinly-bedded dacite tuffs, the rocks varying in color from white, fine-grained sandstones, to coarse breccia made of minute particles of pumice and volcanic ashes, laid down on nearly a level surface. In their undisturbed condition they were flat and overlaid faulted and folded rocks, as may be seen for several miles up Devil's canyon en route to the Gibson mine at Bellevue, and similarly on the mountains to the north and west of Ray.

The schists are part of the Pinal schist series, and the main mineralized belt is formed of these rocks, although their original character has been altered by mineralization. These and the quartzites are cut by diabase and the granite hereinbefore mentioned. The entire series were once apparently covered by dacite, either in the form of flows, or as tuffs.

The schists, when not mineralized, consist of a variety of more or less thinly foliated rocks, varying from hard, dense, quartz-schists, to soft, and lustrous, gray mica-schists. Outside of the sharply-defined mineralized belt, they are unmistakable in character. In the mineralized area it is silicified, reddened by iron oxide, mashed and re-cemented by faulting, so that close inspection is required to recognize the true character of the rock.

The fresh, unaltered rock, varies from gray to almost black; the altered schist from lavender to red and brown. In many parts of the mineralized area it is earthy, and in places consists almost entirely of iron. It is an altered sedimentary rock

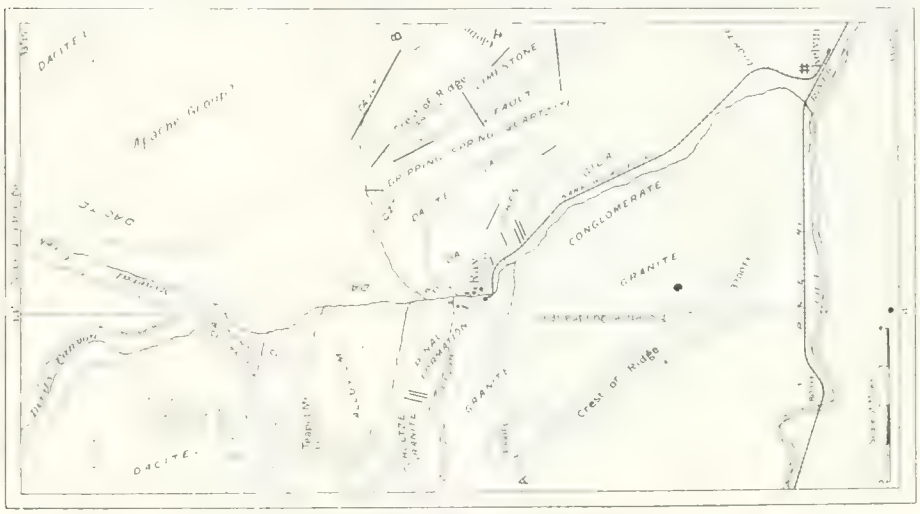
The quartzites, interbedded with red shales, form a series several hundred feet thick. The rock varies from a typical quartzite, a dense crystalline rock, to a fine, white, sugary quartz, resembling an acid granite. In a few instances it is found grading into a coarse conglomerate or well-shaped pebbles. This quartzite occurs east of the Mineral creek, and is not present in the area immediately adjacent to the ore-bodies west of Mineral creek. In the quartzite area east of the creek the rock is cracked and crushed at many points, and substantially impregnated by copper ore, especially close to faults bringing it against diabase.

The limestones occur in the mountains east of Mineral creek, and are found inclined as the crest of the ranges, and lying conformably on the quartzite series. This limestone belt is of no consequence when considering the Ray copper deposits, and is noteworthy only for the occurrence of lead deposits therein.

The conglomerate (Gila) covers an extensive area to the south of Ray. It is a coarse to fine conglomerate, weathering into steep bluffs and towering pinnacles, and was formed later than the ore-bodies.

STRUCTURAL RELATIONS.

The district contains two distinct, sharply-defined, mineralized divisions, separated by Mineral creek. The western



Sketch Map of the Ray District

division is the Ray copper zone in which the great deposits of disseminated copper ore have been found, and is about one-half mile wide and two miles long, running in a northwesterly direction from Mineral creek. The eastern division is not so well defined, and the area in which discoveries of commercial ore have been found is comparatively small, although the area has not been as thoroughly, and as systematically, prospected as in the case of the Ray area.

The Ray ore belt consists of an irregular group of rough-surfaced, red-stained hills, trending from Ray mountain northwest to the New Year group, where the mineralized area stops abruptly near the New Year claim. The area is limited at the south by a line of distributed displacement. On the north its exact boundary has not been determined, although it is known to extend beyond Sharkey canyon. Mineral creek defines its eastern limit, so far as present intensive development is concerned.

As will be noted from a review of the foregoing paragraphs, but three of the rock series—diabase, granite, and the schists—are present in the immediate geological horizon of the Ray copper deposits, although dacite is present in the eastern horizon (commonly termed the Arizona-Hercules), the principal fault of the district, known as Mineral Creek gorge, being the acknowledged line of demarcation between the western and eastern areas.

The granite, which borders, and in places intrudes the schist, probably underlies the entire belt. Apparently it cuts off and replaces diabase in places, especially as in the case of some of the dikes exposed in the mines, suggesting a possible mineralization from the granitic magma which occurs as off-shoots, or tongues, from the underlying mass intruding the schist series. The intrusive granite is in all instances mineralized.

The diabase occurs as intrusive dikes, breaking irregularly across all horizons. It not only cuts the schist series, but has extended, as in the instance referred to in an earlier paragraph where mention was made of its breaking through the quartzite occuring in the eastern division of the horizon, still father into the younger rocks. However, in the Ray Con. area several extensive diabase dikes have been located by means of underground development which do not continue upward through the schists, for the reason set forth in the preceding paragraph.

The Ray Con. deposit consists of highly altered, silicified, reddened schist, sheared and crushed, and mineralized with copper glance and pyrite along joint planes; thin veinlets of quartz, and a net-work of tiny fractures, with impregnation of the rock alongside of the fracture by specks of chalcocite. The capping of the same schist has been thoroughly oxidized to a depth ranging from 75 to 300 feet, and this part is generally barren and leached near the surface, though it contains in part seams of rich oxidized ore, and shades into disseminated ore in depth. Below this capping of oxidized material is the ore-body proper, constituting the zone of secondary enrichment. Here the copper occurs principally as chalcocite, associated with pyrite, and in some instances (as in the Ray Central properties) native copper, and chalcopyrite.

As a rule there is a sharp definition between the zone of oxidized ore and that of sulphides, but tongues of oxidiation extend downward into chalcocite ore.

Beneath the zone of secondary enrichment lies the zone of primary sulphides. The passage is gradual, but occurs within a distance ranging from 25 to 75 feet, with various stages of secondary enrichment in this distance. The primary ore

consists of pyrite, with accessory chalcopyrite, the primary schist ore carrying less than 1% copper, while the diabase will generally average 1.20 to 1.35% copper.

Concerning the eastern, or Arizona-Hercules, area, little can be said in other than a general way, as there has not been sufficient exploratory work performed to merit the attention given the Ray area. This part of the district is entirely different from the western, or Ray zone. It is less sharply defined, and the area within which discoveries of copper ores of commercial grade have been made is small. It consists, essentially of dacite, and dacitic tuffs, forming great tilted blocks between its western boundary, Mineral creek, and the mountains to the east. The copper ores occur in fault-planes, and local impregnations, usually adjacent to diabase masses. In other words, the ore occurs in vein-like impregnations of crushed rock, in or adjacent to faults. In extent this area of the western division is the exact counterpart of the Ray Con. division, being about one and one-half miles wide by two miles long.

The principal feature of the Mineral creek basin is the strong, well-defined fault, running down Mineral creek from the north end, through the town of Ray, and beneath the Gila conglomerate to the south. It is the boundary between the developed area of the Ray Con. property on the west, and the practically undeveloped area of the Arizona-Hercules on the east. Consequently, in view of the marked economic importance of its relation to the two divisions of the district it is worthy of more than passing attention.

This great fault and its parallel sympathetic fractures has, apparently, thrown down the country east of the creek so that the dacitic tuff beds and quartzites once continuous across the valley, are at the creek level on the east side of the fault, while west of the fault the decite and quartzite that once overlaid the schist have been entirely removed. This condition suggests that the eastern area has been thrown down, assuming the western area to have remained in situ. On the contrary, however, it is, perhaps, more reasonable to assume the western area to have been raised, relatively to the eastern division. This is best illustrated by the continuity of the dacitic beds for many miles up Devil's canyon. Therefore, if the secondary enrichment, making ore-bodies of commercial grade, is earlier than the dacite, the area east of Mineral creek is valuable; but, if enrichment is later, the land has no great value for its contained mineral deposits.

ORE GENESIS.

The primary mineralization consists in an alteration of the rocks of all kinds, the primary ore being pyrite with accessory chalcopyrite. The low-grade workable ore-bodies of the district are all secondary reconcentrations of copper derived from lean pyritic material, and their occurence is governed by fault movements occasioning rock fracturing, crushing and brecciation. The primary mineralization was effected by heated gases and vapors emanating from the intrusive diabase. This mineralization by the diabase is apparent in both the eastern and western areas of Mineral creek. The mother rock, diabase, averages throughout the entire area less than 1% copper, but in many instances has been worked as veins on account of its relatively high-grade copper content. The mineralization of the granitic off-shoots or tongues, occurring in the schist in the Ray Con. mines is due to the same causes that formed the workable ore-bodies in the altered schists, viz., the resultant reconcentration of the primary mineralization in the upper zones of the schist area by its oxidation and subsequent deposition at the present horizon, replacing the pyrite particles of the unoxidized zone by glance. The concentration of the copper mineral has been carried on wholly within the schist area. At the contact of diabase with either schist, quartzite or dacite, profound alteration of both rocks occurs with the formation of rich ore. Throughout the district the presence of diabase is generally accompanied by copper. In view of this circumstance it is not unreasonable to believe that the diabase forming a contact with schist and dacite along the Mineral creek fault will be productive of large ore-bodies at a lower horizon. The intrusive granite of the district seems to have played no important part in the matter of ore deposition.

PROSPECTING AND DEVELOPMENT.

The method of prospecting the Ray ore-deposit is the same as that used in other districts, viz., churn-drilling the area in 200 foot sections, and by underground development in the older mines formerly worked for their high-grade ore. As the drilling development now stands the total area prospected covers approximately 300 acres. The average depth of the drill holes is 420 feet, showing an average thickness of 252 feet overburden, and 101 feet of ore. The tonnage calculated within the boundaries of the original Ray Con. property is 77,314,470 tons, averaging 2.17% copper. Of this quantity 65,000,000 tons, having an average of 2.16% copper is classed as fully developed, the remainder having an average of 2.23% copper and being classed as partly developed. Of the total tonnage of ore about 35,000,000 tons occurs in the vicinity of No. 1 shaft, the remainder lying in the west section. The acquisition of the Ray Central property by the Ray Con. gave the latter a property which, in comparison with its own, is superior in relative tonnage of ore developed, and average copper content thereof. While the Ray Central deposit is similar to the Ray deposit (of which it forms a part) it contains an unusually high-grade solid block of copper ore, aside from its tonnage of low-grade ore. There is fully developed in the Ray Central group about 8,000,000 tons of ore averaging 2.35% copper, and a solid block of ground containing approximately 1,000,000 tons averaging 5.93% copper. The probability of increasing the ore tonnage (both high and low-grade ores) is encouraging, and should, at least, develop 40% of the present tonnage.

Underground development continues in the matter of sinking the Ray Central main shaft which is now at the 700 foot level and in very good ore—necessary cross-cuts, and so forth, largely forming a part of the development in this property at the lower levels.

MINING ORE.

The Ray ore-body has its longitudinal axis running northwest from the Mineral creek fault. The capping is not uniform in thickness, averaging about 250 feet in the east section and 350 feet in the west section, the ore-body being 120 feet and 180 feet thick, respectively.

There are three main working shafts; two serving the Ray Con. mines proper, and a third caring for the Ray Central group. The shafts are located on the east side of the ore-body near the railway along Mineral creek. The collars of the shafts are approximately 50 feet above the railway grade, thereby affording facilities for expeditiously and economically handling the ore.

A series of double-track main haulage drifts are provided from the shafts to the ore-bodies that are to be moved. From these haulage drifts extraction drifts are run fifty feet apart to undercut the ore-body at the levels where mining is to be carried on. Chutes are raised twenty-five feet apart on both sides of the extraction drifts at sufficient angle to make the openings large and funnel-shape where they reach the bottom of the stopes, making the chutes approximately twenty-five feet apart over the entire area to be mined. Narrow stopes crossing over the tops of the extraction drifts at right angles are raised from a point twenty-five feet above the drift, and these are carried to the capping overhead, leaving pillars between them.

The stopes are long rooms cutting clear across the ore-body, and having

widths varying in proportion to the ground in which they are being cut. For example, the stopes may be 20 to 30 ft. wide, with pillars between them covering the remainder of the distance, the respective widths of stopes and pillars depending upon the stability of the ground; ordinarily, however, they are 25-ft. each, (leaving an equal pillar between the stopes), thereby corresponding with the chutes. As the stopes are raised, just sufficient ore is taken from them to make room for the miners and drills to work when standing on the broken ore. When the capping is reached work is discontinued and the crew moved to other stopes.

Raises with small cross-drifts penetrate the pillars and afford access to the stopes on either side, and, when sufficient ground has been developed, the pillars are weakened by starting their bases. Later the remaining legs of the pillars are undercut, allowing them to settle, thereby permitting the surface capping to settle down quietly to the level of the broken ore in the stopes. The ore contained in pillars crumbles in the process of the settling of the capping and is drawn out through chutes into the extraction drifts in the same manner that the broken ore in the stopes is withdrawn. The capping is allowed to settle quickest at the farthest point from the main haulage-drift, and the ore is mined in such a way as to permit the surface capping to settle down gradually. Practically no timber is used in the stopes.

MINE EQUIPMENT.

All mechanical equipment at the mine is electrically operated. Power therefor is transmitted from the central power plant at Hayden by a twenty-mile transmission line at 45,000 volts, and is transformed at the sub-stations to 440-volts.

The power plant at Ray includes two 5,000-cu. ft., and one 6,000-cu. ft. compressors (Nordberg), operated by induction motors through rope drive.

The main hoists are Wellman-Seaver-Morgan machines, rope-driven by 350-h.p. motors, the hoisting speed being 300-ft. per minute. These hoists handle 12-ton skips, in balance, and have a capacity of 9,000 tons per diem when hoisting from 300 feet.

The ore is handled underground by trains of five-ton steel ore-cars, operated by electric motors. The underground trains are handled in units of nine to twelve cars to each motor. These are backed into the extraction drifts where the ore is drawn into the cars from chutes. The ore is then taken to the shaft through the haulage drift, and the cars in units of three placed in a tipple emptying them into a 550-ton concrete pocket alongside of the shaft, from which the ore is discharged into the skips.

The skips on reaching the surface dump automatically into steel receiving bins alongside the head-frames. From the receiving bins the ore passes over two 8 in. x12 ft. grizzlies having 4-in. spaceing, the undersize passing over two 4x10 ft. grizzlies having 2-in. spacing, and the oversize going through two No. 8 gyratory crushers, the crushed material from the gyratories also passing over the two 4x10 ft. grizzlies. The undersize from the secondary grizzlies is discharged onto the belt conveyor serving the coarse-ore bins. The oversize from the secondary grizzlies is discharged into a bucket conveyor and elevated to two Garfield 72-in. rolls. The material after passing through the rolls, which reduce to pass a 1½ to 2-in. ring, passes over a third 3x6 ft. grizzly, the undersize from which is discharged to the belt conveyor above mentioned, and the oversize returned to the elevator pit. The crushed ore is distributed to the coarse-ore storage bins on the railroad, the bins having a capacity of 25,000 tons of ore. The ore is automatically sampled before entering the bins, from which place it is drawn into steel hopper-bottom cars for transportation to the mill at Hayden.

Shaft No. 2, about three-fourths of a mile northwest along the strike of the ore-body is equipped the same as shaft No. 1 in both surface and underground equipment. Shaft No. 3, serving the Ray Central mine, is about one-fourth the capacity of the two others, as it is intended primarily to handle only the high grade product from the Ray Central block of high-grade ore.

Main shafts Nos 1 and 2 are equipped with 30-deg. inclined shafts with separate electrically-operated hoists, and are provided with stairways for the use of miners, and skipways upon which is handled five-ton skips for the removal of waste, and for the handling of material into the mine.

GENERAL REMARKS.

The ore from the zones of enrichment (usually adjacent to or not very far removed from the intrusive diabase), is of comparatively high-grade, shading off to the lower grade material in the disseminated zone. While the average copper content of the Ray Con. deposit is stated as 2.16%, it should be borne in mind that, in the areas immediately underlying the oxidized capping, the average grade of ore is materially reduced, so that in many instances the company is compelled to mine and treat ore often-times averaging as low as 1.6%. However, in part, this deficiency in average grade of the large tonnage of ore mined is offset by the tonnage of high-grade ore produced from the enriched zones of the deposit, so that, while the general average copper content is apparently low, it is in fact, largely overcome by the production of higher grade material, thereby tending to increase the average copper content of the product mined and shipped from the entire area. This is clearly illustrated by the present practice at Ray where the stock pile of the Ray Central property (averaging from 2.51% to 6.09%—and sometimes higher), together with other high-grade material at present being mined from the 400-ft. level of the latter mines, are being shipped to the mill for treatment.

Further, it is the intention of the management to immediately extract the higher grade ore deposit of the Ray Central group of properties at the earliest possible moment, and every effort is being put forth to insure an early completion of the work now under way which will afford a means of maintaining a normal average of extraction from 2.16% and less, copper ore.

HAYDEN CONCENTRATOR.

The Ray Consolidated concentrator is located at Hayden, Ariz., about twenty-one miles southeast of Ray. At this point, and immediately adjoining the concentrator, is the Hayden smeltery of the American Smelting & Refining Company.

The central power plant of the company is located at Hayden and supplies the mining, milling, and smelting properties at Ray and Hayden with electric power.

Steam is supplied, in part, by fourteen Heine water-tube boilers of 513 rated h.p. each, equipped with Foster super-heaters. The feed water is delivered by four compound Blake pumps through Foster feed-water heaters. The water from the condensing system is pumped to "Ray" type, cooling-towers. Circulating water is handled by a Nordberg, triple-expansion, pumping-engine.

The four engines installed are horizontal, four-cylinder, triple-expansion, Corliss engines, with 28-in. high-pressure, 52-in. intermediate, and two 54-in. low-pressure cylinders, all having a common stroke of 48-ins. The full-load rating of each engine is 2650 h.p. when receiving steam at 175 lbs. guage pressure, and 75-deg. superheat, and operating at 100 revolutions per minute. To each engine there is direct connected a three-phase, 60-cycle, 6600-volt generator, excited at 120-volts from a 60 k.w. direct-current, engine-driven, generator. These units were built and installed by the Allis-Chalmers Company.

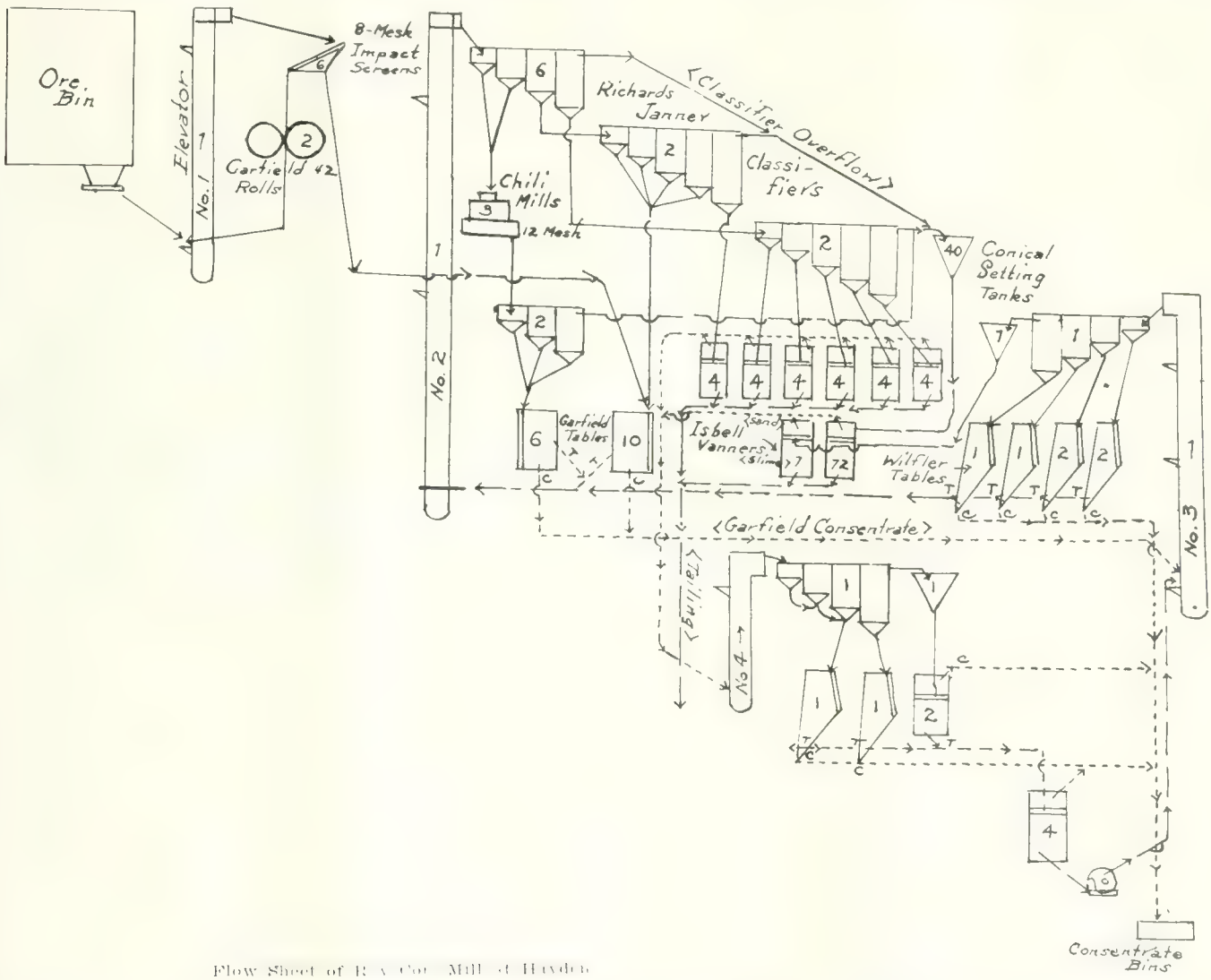
In the valley of the Gila river, approximately a mile from the reduction works, is situated the pumping plant. This plant consists of three wells, each 20 ft. diameter by 40 ft. deep, served by one each 16x18 Aldrich quintiplex pump, directly geared to 350 h.p. induction mo-

tors. The water is pumped to the 10,000,000 gallon reservoir above the concentrator through a 26-in. wooden pipeline constructed to withstand a head of 280 feet. The combined capacity of the three Aldrich pumps mentioned is 12,000 gallons per minute.

MILL AND MILLING METHODS.

The concentrator is divided into eight units, all of the same general type. It is almost a duplicate of the Utah Copper Company's Arthur plant. A brief outline of the mill follows:

The coarsely-crushed ore from the mines enters the building on a trestle at a point which permits of its being dumped into receiving bins. These bins



Flow Sheet of B. & C. Con. Mill at Hayden.

are of steel on re-inforced concrete foundations, and have a capacity of 25,000 tons.

From the ore bins the ore is fed to No. 1 bucket elevator by a caterpillar ore-feeder and belt-conveyor, the ore being raised to the top of the elevator and passed over a set of six 8-mesh impact-screens, the undersize from which goes to the first ten double-deck Garfield tables, and the undersize passing through two sets of 16x42 in. Garfield rolls crushing to as small mesh as possible commensurate with the ore tonnage handled. From the Garfield rolls the crushed material is returned to No. 1 elevator pit.

The No. 2 elevator handles the tailing of the Garfield and Wilfley tables, and discharges same into six 4-spigot, Richards-Janney primary classifiers, the two first spigots of which discharge into three 6-ft. Chilian mills. The third spigots of the primary classifiers discharge into one Richards-Janney 5-spigot secondary classifier, the fourth spigots of the primary classifiers discharging into another Richards-Janney 5-spigot classifier. The third-secondary classifier distributes the product of its first four spigots to the first ten Garfield tables; the fifth spigot of the fourth-secondary distributing to twenty-four Isbell sand-vanners, each respective spigot serving an individual group of four vanners.

The rough concentrate from the Garfield tables is elevated by No. 3 elevator to a 4-spigot Richards-Janney classifier (commonly termed the "Garfield" classifier), the first spigot of which delivers its product to the first two Wilfley tables; the second spigot to the next two Wilfleys, and spigots three and four to individual Wilfley tables.

The Chilian mill product, reduced to pass 12-mesh, is discharged into two Richards-Janney 3-spigot "mill" classifiers. These classifiers deliver an unclassified pulp to six double-deck Garfield tables.

The overflow from the primary, secondary, and "mill" classifiers goes to forty Callow dewatering tanks, the thickened pulp from which is distributed to 72 Isbell slime vanners. The "Garfield" classifier overflow empties into one Callow tank, the thickened pulp from which is treated on an Isbell, or, in some instances, a Johnson suspended type, slime vanner.

The diagrammatic flow-sheet given herewith clearly outlines the milling practice. The small numerals noted in the body of the drawing merely indicate the number of that particular machine in the mill unit. For example, the numeral "3" within the figure representing a Chilian mill, indicates that there

are three mills to each unit; the numeral "40" within the figure, representing settling tanks indicates there are forty tanks, and so forth.

Two notable additions to the ore-dressing practice have been made within the past few months. The first considers the classifying of the Garfield table concentrate in a Richards-Janney 4-spigot classifier, and the distribution of the classified pulp from each respective spigot to separate groups of Wilfley tables, the overflow from the classifier discharging into one settling tank, the thickened pulp from which is treated on an Isbell, or Johnson, slime vanner. This classifying of the Garfield table concentrate merely serves to complicate the practice creating a secondary closed-circuit which is, in turn, merely a makeshift with no special advantage over treating an unclassified Garfield concentrate on the Wilfleys, as was the former practice. The added expense of operation of this particular improvement, together with its metallurgical inefficiency, does not justify its maintenance, only as a means of increasing the tonnage handled per unit, in which instance it has a place.

Another recent improvement to the equipment of the concentrator is the "concentrate re-treating plant" which will be noted in the flow-sheet cut given herewith. But two of these new plants are at present installed in the mill, but it is the intention of the management to install similar plants in every other unit, making a total of four in the present building. The units in which the treating plants are installed replace four slime vanners, thereby reducing the number of that particular machine from 72 to 68 to the unit.

All the concentrate from the mill, excepting that produced by the Wilfleys, is elevated to a 4-spigot Richards-Janney classifier from which the third and fourth spigots respectively discharge to separate Wilfley tables, the overflow from the classifier emptying into a settling tank, the thickened pulp therefrom being treated on two Isbell sand-vanners. The tailing from the Wilfleys and Isbell vanners is treated on four Isbell slime vanners. The tailing from these last mentioned vanners is returned to the No. 3, or Garfield, elevator and after classification are returned to the first six Wilfleys tables, eventually passing out as refined concentrate, or as tailing from the vanner group.

PERTINENT COMMENT.

At present but six of the eight units of the concentrator are in operation; the two others are, however, practically completed, and could, if desired, be placed in commission on short notice, but the mines are not yet prepared to yield the large tonnage required to maintain the mill rating for a considerable interval of time, consequently no effort is being made to place them in operation.

Each unit of the concentrator is designed to treat 1000 tons of ore every twenty-four hours, and, under normal conditions, (that is, operating on a tonnage basis of 800 to 1000 tons per diem), effects a very satisfactory recovery of the copper contained in the better grade ores mined from the enriched ore-bodies at Ray, considering the general mill plan.

However, the customary practice at Hayden, as at the other plants controlled by the same management, is to operate each unit of the mill at from 30 to 60% overload. The result of this practice is that the extraction of copper mineral from the ore milled apparently approximates the average percentage recovery of some of our most modern ore-dressing plants, which latter, at their respective normal rating, generally effect a recovery ranging from 69% to 77% of the contained copper in the ore milled, it being understood that the ore treated is, in the instance mentioned, of the same general character and grade.

From the foregoing it will doubtless be of interest to note that two methods are employed at Hayden, and the other plants under the same management, to make it appear that its milling practice is equally as efficient as the best. A brief outline thereof follows:

The first method employed considers the treatment of an ore averaging, say, 1.6147% copper per ton, the percentage recovery effected therefrom approximating .6835% of the contained copper, and the concentrator being operated at its normal capacity of 1000 tons per diem. Of course, it is comparatively easy to calculate the quantity of metallic copper recovered. However, the figures given are merely representative of "near-official" statements. The facts in the case are: First, maximum tonnage of ore is handled through the concentrator; secondly, the copper recovered is computed; thirdly, the percentage recovery takes care of itself; finally, by means of an elementary formula, a report is made which outlines, briefly, normal conditions of operation as aforementioned, care being exercised to make the copper produced bear a reasonable ratio of percentage recovery to a fixed tonnage of ore—and by all means not the quantity actually milled. It is simply a juggling of figures in which only the actual copper produced is considered—tonnage, percentage recovery, and other factors, being worked out as desired.

The second method contemplates the treatment of a higher grade ore than the general average mine-run, in which instance the tonnage passed through the mill is considerably less than the normall mill capacity. The conditions are, however, similar to those above mentioned.

At the present time the general average grade of ore treated in the concentrator averages from 2.00% to 2.86%, and higher, the percentage extraction ranging from 52% to 60%—dependent upon the tonnage handled, which fluctuates from 1200 to 1600 tons per diem. Maximum efficiency is sacrified to tonnage.

No better illustration of the inefficient operation of the concentrator is required than to call attention to the concentrate re-treating plant referred to in an earlier paragraph. Its installation plainly evidences the imperfect separation of the copper minerals from the ore treated in the plant as now arranged. Further, the sections of the mill where important changes of equipment readily could be made, are not given the attention necessary to improve the practice. To the contrary, the practice in lieu of being simplified, is constantly undergoing changes which serve to complicate the situation.

It seems strange that the management of the Ray Consolidated Copper Company persists in the application of the same general milling practice that is in vogue in its Utah, and New Mexico, properties; especially, in view of the fact that the physical character of the ores in the three districts where extensive operations are now being carried on, are widely different. To this may be added the statement that the method of treatment outlined has not, in any instance, proved successful, although it has been tried out on ores representing practically the entire field of so-called "porphyry" copper ores, or, "disseminated" low-grade copper deposits.

It will be of interest to readers to learn that there is in successful operation, in practically the same district as the Ray Con. properties, a modern concentrating plant treating the same character and grade ore as the Ray Con. Company, and effecting an average recovery of 76.85% of the contained copper of the ore treated. A description of the concentrator in question will appear in an early issue of Mines & Methods, and a comparison of the relative efficiency of the two plants can then be made. Aside from the general treatment plan of the plant to be described as above mentioned, is the fact that several important changes have been made within the past few months which have tended to considerably increase the ef-

ficiency of plant referred to, in both a mechanical and a metallurgical manner.

HAYDEN SMELTERY.

In view of the close relation of the Hayden smeltery to the Ray Consolidated Copper Company's concentrator at Hayden a brief description of the former is given.

The Hayden smeltery lies about one-fourth mile southeast of the Ray Con. concentrator. Originally it was to have been constructed and operated by the latter company, but, through negotiations with the American Smelting & Refining Company, whereby the Ray Con. was assisted in the further financing of its other properties, an exchange was effected.

Primarily the smeltery was built to handle only the concentrate produced by the Ray Con. company, but in view of the probable construction of a branch railroad from Hayden to the Miami district the smeltery will doubtless be greatly enlarged.

The Gaggenau [illegible] at Hayden

Concentrate from the concentrator is transported to the smeltery ore-bins in standard-guage steel 50-ton cars. From the ore-bins the concentrate is delivered over a belt-conveyor to eight 24-ft. McDougal roasters. The calcined material from the roasters is drawn into electric-driven hopper-bottom steel cars and emptied into hoppers feeding two 20x112 reverberatory furnaces, the furnaces being oil-fired. The copper matte from the reverberatory furnaces is delivered to two Pierce-Smith basic converters, the product from which is, in turn, cast into 375-lb. ingots and shipped to the refinery.

Six 400 h.p. Babcock and Wilcox water-tube boilers, operating at a guage-pressure of 175-lbs. are fired by the waste heat from the reverberatory furnaces, the steam generated by these boilers being piped to the Ray Con. power plant.

The smeltery derives its electric power from the Ray Con., and the Nordberg blowing engine, the oil pumps tending the furnaces, and other similar equipment is located in the Ray Con. power house, the arrangement having been made for an exchange of steam from the smeltery waste-heat boilers for all other power requirements, such as electric-power, and so forth, from the central power plant.

The equipment of the Hayden smeltery will be increased as occasion demands, and it is the intention of the A. S. & R. Co. to enter the field for both custom lead and copper ores at an early date. Consequently, there will be added to the present equipment several large water-jacketed cupola lead, and copper, furnaces, besides later the construction of its own power plant.

THE DIVINING ROD

The United States Geological Survey states in Water-Supply Paper 255, entitled "Underground Waters for Farm Use," just reissued, that no appliance, either mechanical or electric, has yet been devised that will detect water in places where plain common sense and close observation will not show its presence just as well. Numerous mechanical devices have been proposed for detecting the presence of underground water ranging in complexity from the simple forked branch of witch hazel, peach, or other tree to more or less elaborate mechanical or electric contrivances. Many of the operators of these devices, especially those who use the home-cut forked branch, are entirely honest in the belief that the working of the rod is influenced by agencies—usually regarded as electric currents following underground streams of water—that are entirely independent of their own bodies, and many people have implicit faith in their own and others' ability to locate underground water in this way. In experiments with a rod made from a forked branch it seemed to turn downward at certain points independent of the operator's will, but more complete tests showed that this downturning resulted from slight and, until watched for, unconscious muscular action, the effects of which were communicated through the arms and wrists to the rod. No movement of the rod from causes outside of the body could be detected, and it soon became obvious that the view held by other men of science is correct—that the operation of the "divining rod" is generally due to unconscious movements of the body or of the muscles of the hand. The experiments made show that these movements occur most frequently at places where the operator's experience has led him to believe that water may be found.

The uselessness of the divining rod is indicated by the facts that it may be worked at will by the operator, that he fails to detect strong water currents in tunnels and other channels that afford no surface indications of water, and that his locations in limestone regions where water flows in well-defined channels are no more successful than those dependent on mere guess. In fact, its operators are successful only in regions in which ground water occurs in a definite sheet of porous material or in more or less clayey deposits, such as pebbly clay or till. In such regions few failures can occur, for wells can get water almost anywhere.

The only advantage of employing a "water witch," as the operator of the divining rod is sometimes called, is that crudely skilled services are thus occasionally obtained, for the men so employed, if endowed with any natural aptitude, become through their experience in locating wells shrewd, if sometimes unconscious observers of the occurrence and movements of ground water.

To prevent rubber packing from blowing out, cut pieces of ordinary wire window screen the size of the packing and place on each side of it. The wire beds itself into the soft packing and holds it in position.

From Copper To "Gold Mines"

This space is reserved for the picture of A. F. Holden the other eminent engineer who lent his name and gave his endorsement to the electrifying report on Alaska properties submitted herewith and which will be reproduced from month to month.

NOTED ENGINEERS JOIN BROKERAGE HOUSE IN A REMARKABLY PECULIAR PRESENTATION OF AN ALASKA GOLD MIRAGE.

We have considered the PROBABLE capital requirements for a capacity of 6,000 tons per day, which contemplates a hydro-electric power plant; mine development and equipment including all the necessary living quarters, both at the Perseverance mine proper and at the mill, and driving the long adit tunnel. We BELIEVE that $4,500,000 will do this owrk.

Our belief is that the substantially INDICATED ore body is about 4,500 feet long by seventy feet wide. The value of the 600,000 tons of ore THAT HAVE BEEN MINED FROM THIS BODY IN THREE DIFFERENT LARGE STOPES INDICATES that a recovery of at least $1.50 per ton can be made. We BELIEVE that there will be 75 cents per ton profit in this grade of ore. The Sheep Creek Tunnel which will be driven on the vein as the main haulage level, will develop this ore body at an average depth of about 2,200 feet on the dip of the vein or about 700 feet deeper than present developments.

The character of this vein is similar in A VERY GENERAL WAY to other large deposits of gold ore in the same vicinity in which the values at a vertical depth of 1,600 feet, or 2,000 feet on the dip of the vein from its apex, are practically the same today as they were on the surface, and have been throughout the development of THE DEPOSITS IN QUESTION. We visited these mines and saw THEIR deep levels, and if there is any inference to be drawn from the continuity of THESE ore bodies, WHICH ARE NOT, HOWEVER ON THE SAME VEIN AS THE PERSEVERANCE, one MIGHT BE TEMPTED to say that there is a PROBABILITY of ore 2500 feet deeper than the so-called Sheep Creek Tunnel which we contemplate driving, BUT, while the PROBABILITY is there of the vein and values extending to great depth, THERE IS NOTHING TODAY TO WARRANT ANYBODY IN STATING THAT IT IS A FACT THAT SUCH WILL BE THE CASE.

There are substantially 50,000,000 tons in the ore body we consider definitely INDICATED. There is a PROBABILITY of another 2,000 feet to the east of the 4,500-foot ore zone previously mentioned which, from surface indications, would seem FAIRLY CERTAIN to contain ore. Beyond this is some 1,800 feet of the vein concerning which we have NO FINAL OPINION one way or the other, AS WE VISITED NO WORKINGS OR OUTCROPS from which we could secure sufficient data to form accurate deductions. While we cannot at this time state that there IS ore here, there were several SMALL MINES worked almost at the extreme east end of the vein on this property, which INDICATES that this 1,800 feet will undoubtedly produce considerable ore and PERHAPS LARGE QUANTITIES. If we do not consider this in the PROBABILITIES, it is certainly well within the POSSIBILITIES.

This letter is based solely on a consideration of $1.50 recoverable value as ore. If one should figure on lower values assuming 75 cents as the total cost of mining and milling, the tonnage now indicated is INDEFINITE, but certainly enormous. We BELIEVE that sound mining business will INDICATE that for the installation now proposed and for an operating period of, say, two years, IT WILL BE WISE TO CONFINE OUR WORK TO THE HIGHER GRADE ORE. There can be, in our opinion, little doubt that at some time in the comparatively near future A VERY MUCH LARGER PLANT than the one now proposed will be installed for the purpose of working a larger tonnage of the normal grade ore we now EXPECT will be developed, or of utilizing the apparently vast quantity of lower grade material.

The INDICATED earnings from the installation now contemplated are approximately $1,500 000 per annum. Considering the TREMENDOUS POSSIBILITIES, and we use the word "tremendous" advisedly, we BELIEVE this mine to be a LEGITIMATE purchase at $15,000,000 and A BARGAIN at $12,000,000, provided that, in both cases, a development,equipment and working fund of $4,500,000 is made available. You must understand and appreciate that we do not consider the 6,000-ton per day development and installation as the ultimate possibility of the mine or anywhere near it. The POSSIBLE tonnages of ore INDICATED in this property APPEAR to be greater than any vein deposit WE know about.

We EXPECT the first unit of the new mill to be in operation on or before January 1st, 1915. We really BELIEVE that, barring accidents the time MAY be made July 1st, 1914.

(Signed, July, 1912.) D. C. JACKLING.
A. F. HOLDEN.

Already the management of this herculean undertaking is preparing to increase the stock and issue bonds under the bold assumption that the 50,000,000 tons of ore now "believed" to exist will be increased to 200,000,000 tons within a short time. This showing, an article in the Salt Lake Telegram of the 2th, says, will require making the proposed 6000-ton mill a 20,000-ton affair. Thus, before it is known whether the ore can be treated at any profit—really before it is known whether the ore will average even 25 cents a ton in recoverable value, the company's proposed new financing scheme is being exploited. First they tell you they "believe" $4,500,000 will be ample for all purposes of development and equipment. Then, almost before the ink is dry on that published statement, they begin paving the way for bleeding the public proper. The next stock will be put out at $20 or $25 a share, they promise.

COPPER ORE TREATMENT BY FLOTATION PROCESS

By J. W. ASHCROFT*.

The Kyloe Mine is situated near the township of Adaminaby, and is thirty-two miles from Cooma, New South Wales, the nearest railway station.

The orebody occurs as a lode quartz felsite, which, at the lower levels, passes into aplitic granite. In the upper levels of the mine there is an occurrence of slate which also shows on the surface, but is not present in the deeper portions of the mine.

At the time when the present management took charge of the mine, the oxidized ore was practically exhausted. The ore, as now mined, consists of quartz with chalcopyrite and small amounts of bornite and iron pyrites. The composition of a typical sample of clean, rich, hand-picked ore is as follows:

	%
Cu.	21.2
Fe.	24.3
SiO_2.	28.9
S.	25.1
Bi.	trace
Au and Ag	trace
	99.5

In places the orebody is found in the form of small veins in a crushed felspathic filling. A clay seam, or gouge varying from one inch to over a foot wide, occurs in the ore-channel throughout the workings. This clay, and that derived from the kaolinizing of the felspathic portion of the granite filling, was the cause of a good deal of trouble in the flotation treatment. A remedy was subsequently found in the addition of a large proportion of clean quartzose ore.

THE ORIGINAL PROCESS OF TREATMENT.

In the mill, as originally erected, the ore, after hand-sorting at the shaft bins (where waste was eliminated, and some clean copper ore picked out for shipment), was passed through a rock-breaker and broken to 1½ in. gauge and delivered on to a picking-belt, where as much as possible of the clean, rich ore was bagged for shipment.

The remainder then passed into the mill ore-bins assaying from 5 per cent to 5½ per cent of copper. A typical analysis of the average ore-treated is as follows:

	%
Iron	6.5
Copper	4.7
Sulphur	4.2
Lime	3.4
Insoluble	79.4
	99.2

From the mill-bin the ore was fed mechanically into an elevator, which discharged into a shaking screen. From this the oversize was fed, with water, into a set of Cornish rolls, and the undersize went to a May jig.

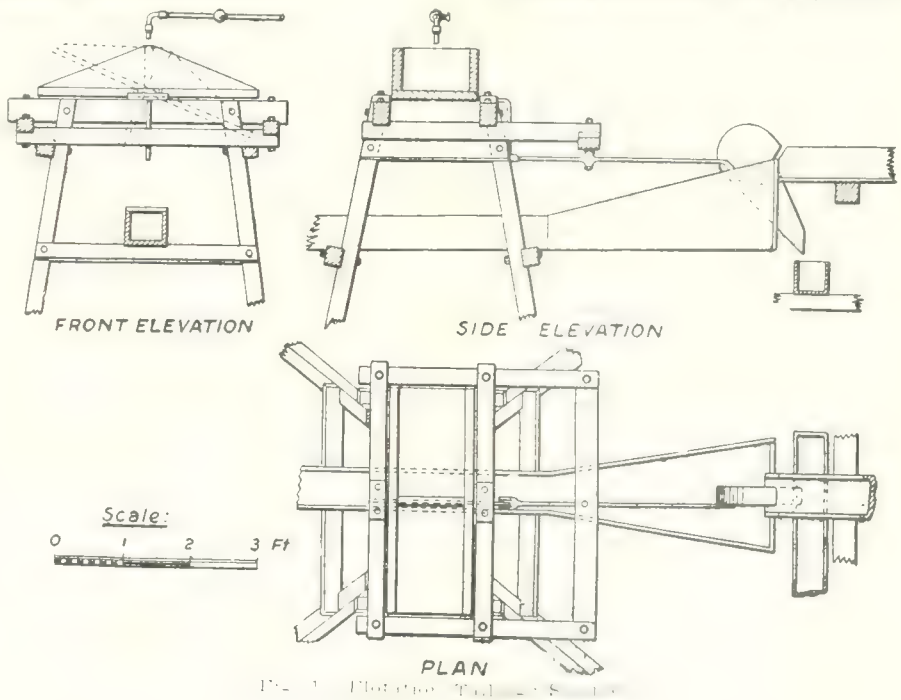


Fig. 1.—Flotation Tailings Separator.

From the rolls the crushed ore fell into an elevator, and was once again fed into the shaking screen, together with the ore from the bins.

This arrangement is shown in the following flow-sheets, Nos. 1 and 2:

An automatic sampler was placed in the launder leading to the jig, so that all material passing into the mill for treatment was correctly sampled.

While no originality is claimed for this sampler, a drawing of it is shown on Fig. 1, as it is doing excellent work and may be of use in other plants.

The head product from the jig was dried, bagged and sold to a smelter, the tail ran to waste, and the middle products were reground wet in a ball mill, and, after classification, passed over Wiffley and Card tables, the overflow from the classifier being thickened in a pulp-thickener, from the overflow, which consisted of practically clear water, was run to waste.

An abundant supply of good soft water was obtained from the Eucumbene river, 1½ miles away. Subsequent experiments at other mines have shown that the character of the water has a noticeable effect on treatment by flotation.

This mill did work over a period of 18 months, recovering 74 per cent of the copper contained in the mill feed in the form of a concentrate carrying 19 per cent to 20 per cent of copper.

The mill concentrates were formerly smelted on the ground and the product shipped as a 50 per cent copper matte, but owing to the high cost of firewood and fluxes, and an all-round increase in the rates paid for labor, it became more profitable to sell the concentrates to a smelter.

The cost of transport is extremely high, viz., £2 15s. 0d. per ton of concentrates from mine to the smelting works, and it is, therefore, essential to

Paper No. 97, I.M.M.

produce concentrates of as high a grade as possible. By lowering the grade of the concentrates, a higher extraction could have been obtained, but the extra cost of transport, and the lesser price paid by the smelter on the lower grade product, made it more profitable to ship one containing at least 20 per cent of copper.

EXPERIMENTAL FLOTATION TREATMENT.

With a view of obtaining a better recovery and a higher grade concentrate, experiments were made with the Potter and the Minerals Separation process of flotation, and, with the preliminary tests proving satisfactory, it was decided to erect a flotation plant; that of the Minerals Seperation was chosen, as it possessed advantages over the others as far as the treatment of Kyloe ore is concerned, in that it is more simple in operation on this particular ore.

As the process was at that time untried on a working scale for copper ores, the old plant was left intact and a small annex added to the mill building to contain the flotation plant, and the lay-out so arranged that the whole of the work could be turned over alternatively to the original plant at any time; this proved to be a wise precaution, as radical alterations were necessary to the flotation process as first introduced before success was achieved.

The flow-sheets accompanying this paper show the evolution of the present method from the original mill as already described.

The flow-sheet, as far as the point of departure in treatment after the jig, has already been given and are common to all. Sheets Nos 3 and 4 show:

3. The first lay-out of the flotation plant;

4. The present arrangement of flotation plant as now in successful operation.

PROCESS AS FIRST INTRODUCED.

This plant is divided into two sections, i.e., a grinding section and a flotation section.

The grinding was effected in two 8-ft. Forwood-Down pans; as originally erected these were made with a classifying discharge and were driven at 30 rev. per minute.

The flotation machines are of the latest type used at Broken Hill on the zinc-lead seconds, with six stirring boxes, each 16 in. square, as shown in Fig. 2.

The departure from the former method of concentration took place at the jig. The first hutch product was clean concentrate as before, the second and third hutch product was dressed on a No. 5 Wilfley also as before; the tailings from this Wilfley, together with the No. 4 hutch product and the jig tails, were sent to the grinding pans, and the overflow from classifier at the head of jig, together with the overflow from end of jig, passed through a pulp-thickener of the baffle-board type, the spigot from which discharged into the launder running to the flotation machine together with the discharge from the grinding pan. No. 3 flow-sheet on shows the first lay-out of the flotation plant.

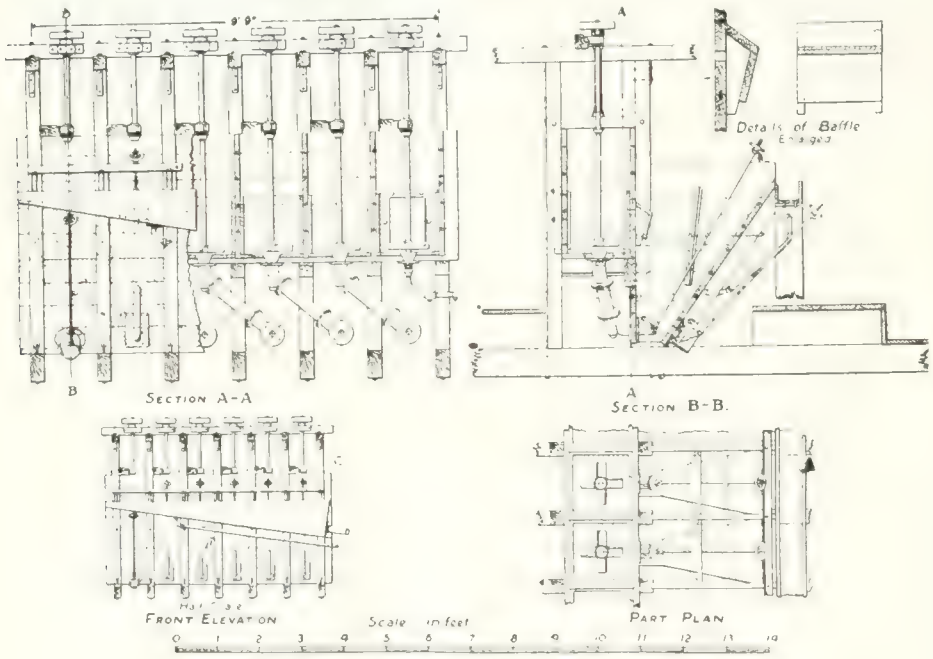


Fig. 2. General Arrangement of Flotation Machine.

The pulp-thickener, which is an adaptation of a well-known type, calls for special attention, being of cheap and simple construction, and working admirably. The details of this apparatus are shown on Fig 3.

The flotation machine consists of a series of six square boxes fitted with revolving impellers, and each box connected to an outside chamber in which the separation of the mineral from the gangue takes place. From the bottom of the No. 1 flotation chamber the pulp is drawn by the action of the second impeller into No. 2 stirring box and from No. 2 flotation chamber to the No. 3 box, and so on; the pulp from which the mineral has been separated being finally discharged from the bottom of the No. 6 flotation chamber.

The flow from the flotation chambers through the diagonal pipes into the stirring boxes is regulated by a valve on the top of each pipe, and the tailings discharged by a similar valve.

In this flotation process, as used by Kyloe, no acid is required, and the whole operation is conducted at ordinary temperature. The oil used in crude eucalyptus oil containing a large percentage of philandrene. This oil is manufactured in the district, and costs 8.5d. per lb., delivered at the mine. A great deal of information concerning the manufacture and properties of the various eucalyptus oils is found in a publication entitled "Eucalyptus and their Essential Oils," written by Messrs. Baker & Smith, and published by the authority of the State Government of New South Wales.

DEFECTS IN THE PROCESS.

A number of defects soon revealed themselves in both sections of the plant. In the flotation machine the original slicing valves used were not sufficiently sensitive to regulate the flow properly, the correct adjustment of which through the different boxes has an important bearing on the successful working of the process, and the slicing valves were therefore replaced by flap valves, operated by a rod with threaded end and hand wheel, which arrangement proved entirely satisfactory, and permitted very delicate adjustment.

As soon as work was started it was found that owing to the flotation chambers being all of the same width, while the amount of mineral to be floated became less in each one towards the tail end of the machine, the froth became very thin and poor after the first two boxes; to remedy this and give the froth a greater density and thickness, the flotation chambers were contracted on top by means of "crowding boards" which reduced their surface to widths varying from 11½ in. on No. 1 to 4½ in on No. 5. No. 6 chamber was shortened by putting in a watertight bulkhead in addition to the crowding boards as in the other chambers; this narrowed the surface to 4 in. and shortened the distance through which the poor froth had to travel by one half, and gave less chance for the mineral to drop away

from the froth into the tail before it was delivered into the discharge launder.

The machine now appeared to work fairly well, but the following samples, taken from the discharge lip of each of the flotation chambers, showed that the product from Nos. 4, 5 and 6 chambers were not sufficiently rich to be profitably shipped, so the concentrate launder was divided and arranged so that the products from Nos. 1, 2 and 3 chambers went to the concentrates bin, while those from Nos. 4, 5 and 6 were returned to No. 1 box in the machine and re-treated.

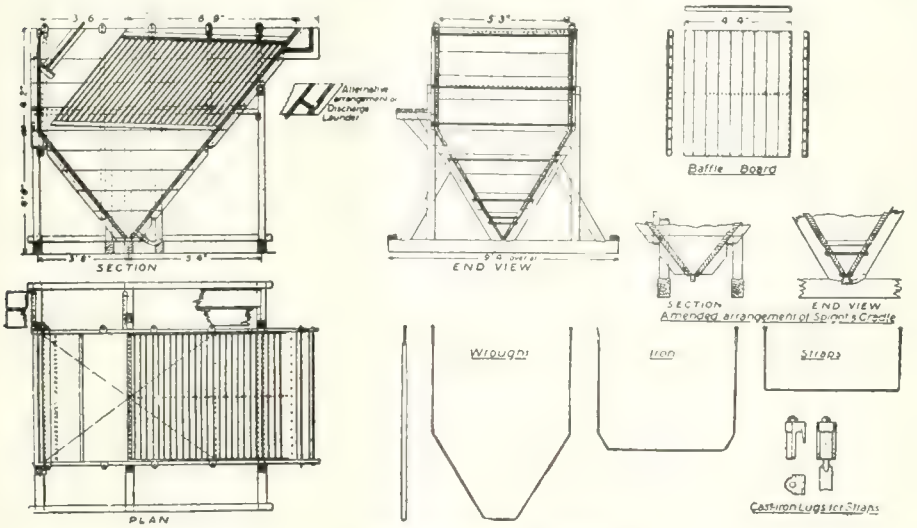


Fig. 3.—Improved Pulp Thickener.

The samples referred to were as follows:

	Copper	Silica
	%	%
No. 1 Overflow . . .	27.2	21.2
" 2 "	24.1	41.5
" 3 "	22.3	59.6
" 4 "	15.6	61.0
" 5 "	14.3	60.7
" 6 "	9.4	68.7

After a short run it was found necessary to insert iron liners in the stirring boxes, as the wooden ones wore away very rapidly. The opening into the boxes through which the pulp was drawn by the action of the impellers was also modified and made bell-mouthed, which improved the working considerably. Inspection doors were also provided, so that the wear could be ascertained without dismantling the boxes

As soon as the machine was again working normally, samples of the feed and tail were taken regularly, and the result of a week's run was as follows:

	Feed. % Cu.	Cons. % Cu.	Tails. % Cu.	Recov. %
1st day	5.1	20.1	2.0	67.5
2nd day	4.4	24.2	2.3	52.7
3rd day	4.0	19.1	1.2	73.8
4th day	4.7	19.0	2.2	60.1
5th day ...	4.0	23.6	1.5	66.7
6th day	4.1	23.5	2.2	49.8

This, although an improvement, was not yet satisfactory, so sizing tests of the various products were made to discover, if possible, in what direction to look for further improvement. The results were as follows:

Mesh.	Feed. % Wt.	% Cu.	Concentrates. % Wt.	% Cu.	Tailings % Wt.	% Cu.
+ 20	1.52	2.20	0.18	17.50	1.85	2.0
+ 40	13.17	1.20	0.30	17.00	17.53	1.2
+ 60	15.10	0.80	0.31	18.50	20.77	0.7
+ 80	3.55	1.15	0.52	24.70	6.10	0.6
+100	22.50	1.40	7.42	53.60	21.40	0.6
+130	3.62	3.80	1.55	21.20	4.20	0.5
-130	40.40	5.45	89.60	23.75	28.00	1.2

These figures indicated that the material being fed into the flotation machine was not sufficiently uniform, and that it containedl too large a quantity of comparatively coarse particles which could not be held up in the froth, and which in falling would carry down some of the finer particles that would otherwise have remained suspended. Improvement, therefore, lay in the direction of finer grinding and closer sizing.

Attention was now given to the crushing unit, and, as a preliminary, sizing tests were made of the infeed and discharge of the two grinding pans, which gave the following results:

	No. 1 Pan. Feed. % Wt.	Discharge. % Cu.	% Wt.	No. 2 Pan. Feed. % Cu.	% Wt.	Discharge. % Cu.	% Wt.
+ 16	16.4	2.3	—	—	10.0	1.4	—
+ 20	33.9	1.6	10.0	1.71	9.7	1.0	0.3
+ 40	13.0	1.3	17.1	1.2	10.5	1.2	11.0
+ 60	18.3	1.2	31.9	1.4	18.2	1.5	30.9
+130	6.9	2.1	16.9	3.2	17.0	3.0	23.4
+130	11.5	3.7	24.1	5.0	24.8	6.7	34.4

The No. 1 pan was taking the product of Nos. 2 and 3 hutch from the jig after being dressed on a Wilfley table The discharge was 21 in. above the bottom of the pan.

The No. 2 pan was taking the overflow from the classifier at the head of the jig and a portion of the jig tail, the discharge was 22 in. above the bottom of the pan. The pans as arranged with the classifying feed would not take the whole of the jig tail.

As the foregoing sizing tests showed that an unduly large percentage of material, larger than 40-mesh, was contained in the ground pulp, the discharge of the pans was slightly raised and the product again sized, with the result that while the quantity of slime made was largely increased, the amount of product, larger than 40-mesh, was very little reduced.

The working of the machine was still unsatisfactory, the recoveries in the whole mill being only very little better than with the old system; but as all laboratory tests showed that a much better extraction was possible when the conditions were favorable, and as the trouble appeared to be chiefly mechanical, it was decided to rearrange the whole of the flotation plant so as to remedy the most apparent defects, which were:

1. The excessive amount of oversize in the feed to the stirring boxes.
2. The excessive dilution of the pulp.
3. The irregularity of the overflow from the flotation chambers due to the irregularity of the feed, and of the speed of the impellers.
4. The want of proper means to control the supply of oil.

REARRANGEMENT OF PLANT.

In order to remedy the defects mentioned the mill was turned over to the old system while the following alterations were made in the flotation plant:,

1. The grinding pans were altered from the classifying discharge, to the positive feed type, and were arranged to discharge on to revolving screens so as to keep the feed to the flotation machine more even in size.

2. The pulp thickener was moved and placed between the screens and the flotation machine so as to keep an even feed to the stirring boxes and to regulate its density.

3. The flotation machine was connected to a separate engine with a sensitive governor so as to keep the speed of the stirrers constant

4. An apparatus was made for adding the oil to the pulp in such a manner as to ensure an even flow.

The revolving screens are of a type used in Broken Hill and are shown in Fig. 4; they do excellent work and are economical to run.

The screening cloth used in Greening's L. W. C. 600-mesh with aperture 0.0268 in.; size A.K.D. 900-mesh with aperture .00217 in. was also used at first, but the L.W.C. was found to last longer and to give equally good results and so

was finally adopted. The screens last about ten weeks for each covering.

The method of adding the oil to the pulp, which was finally adopted, consists in placing two drums, one above the other; in working, the top drum is filled with oil and the flow from this to the lower one is regulated by a floating ball valve, thus ensuring a constant head in the lower drum. From the lower drum the oil drops at a constant rate into the launder which carries the pulp from the screens to the flotation machine, at the rate of about one drop per second, amounting to 0.65 lb. of oil per ton of dry ore treated.

In the rearrangement of the plant no concentrating tables were used at all, but the whole of the products from the jig, excepting that from the No. 1 hutch (which was bagged for shipment) were sent direct to the flotation plant in order to give a larger percentage of mineral there, and so form a thicker froth in the flotation chambers.

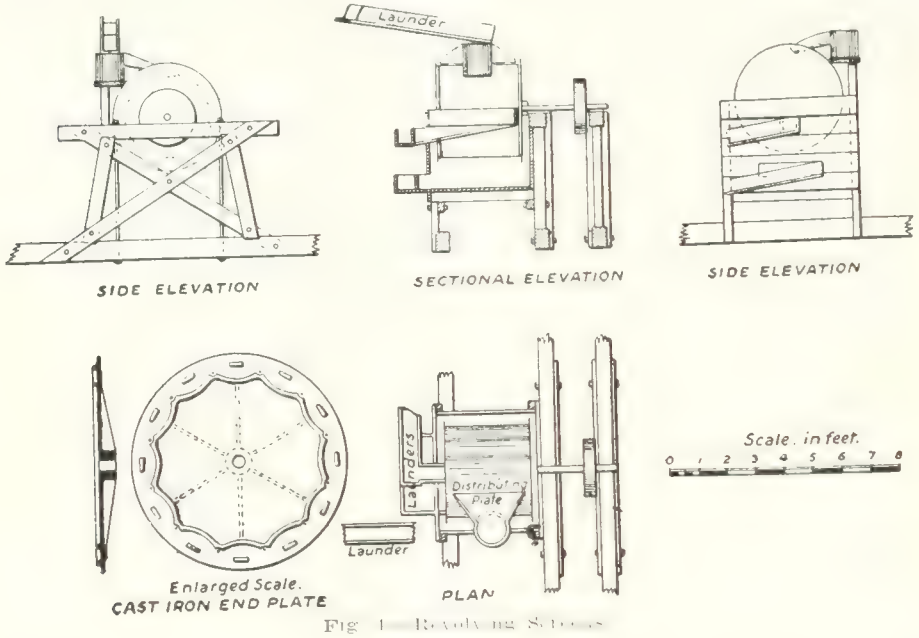


Fig. 1. Revolving Screens.

Flow-sheet No. 4, here given, shows the rearrangement, and it will be seen from it that the only actual additions to the plant as originally designed are the screens and elevator, but that there is a considerable difference in the general lay out.

Having remedied the defects in the grinding plant the flotation machine began to do much better work, the result of a six days' run being as follows:

	% Cu	% Cu	% Cu.	%
1st day ..	3.9	23.8	1.1	75.2
2nd day .	4.0	24.4	0.9	80.4
3rd day ..	4.7	25.1	1.0	82.6
4th day	4.8	25.8	1.4	74.8
5th day	5.3	26.1	1.4	78.0
6th day	4.1	25.6	1.5	67.3

The extraction percentage above is worked out on the following formula, viz:

$$\frac{A + 100\ C}{A} = \%\ \text{extraction}$$

Where A = percentage of value in feed
B = " " " tail
C = " " " concentrate

which is convenient for approximate estimations when it is impracticable to weigh the products.

It was soon found that a certain type of feed gave bad results, i.e., where there was a large percentage of oxidized and kaolinized lode matter, and the high tail values in the last three days' work given above were due to this cause.

On one occasion when there was sufficient of this deleterious material to discolor the pulp to a dirty yellow, practically no flotation took place, the pulp leaving the boxes at approximately the same value as it was fed in. There was no true froth, only large, shiny bubbles, and a little coagulated sulphide which overflowed the flotation chambers; samples taken from each chamber at this time gave the following results:

Feed % Cu.....	3.5
Chamber No. 1 % Cu	9.3
Chamber No. 2 % Cu.	8.2
Chamber No. 3 % Cu.	6.3
Chamber No. 4 % Cu	7.3
Chamber No. 5 % Cu.	6.5
Chamber No. 7 % Cu .	8.8
Tails	3.0

The film forming these large bubbles was very tenacious, and no improvement took place while the feed was discolored in this way.

Tests made indicated that the deleterious effect was due to the physical rather than the chemical properties of the material and to the peculiar nature and excessive quantity of the slime produced by it; in order to determine definitely what effect the large quantity of slime had upon the working of the process, daily sizing tests were made of the infeed to the flotation machine extending over a considerable period, and these showed that when this contained more than 40 per cent which would pass through 130-mesh, the quality of the work began to fall off, while the best results were obtained with from 20 per cent to 30 per cent of this size in the feed.

Since the trouble arising from the "dirty" ore, the mill feed has been regulated so as to contain only a small percentage of this in the total feed, and the result has been uniformly good, only once in a while the separation becomes poorer and this can now be very quickly corrected by the man in charge, who can tell by the appearance of the froth; once running in proper order, the machine is easy to regulate, and will sometimes run for 48 hours without being touched, but at others, if the character of the feed changes, it will require frequent adjustment until the feed is again regular in composition.

The results of a week's run of the flotation plant when it was in good working order were as follows:

	Feed. % Cu.	Cons. % Cu	Tails. % Cu.	Recov. %
1st day	3.8	25.1	0.95	77.9
2nd day	3.0	23.3	0.85	74.3
3rd day	3.0	24.2	0.65	81.0
4th day	3.15	23.7	0.55	84.5
5th day	4.1	25.6	1.05	77.5
6th day	4.4	24.6	0.90	82.5

These figures show a recovery better than is obtainable by any other known concentrating process on this class of ore, and when it is remembered that, in the case of the Kyloe ore, the mineral contained is nearly pure chalcopyrite, the tailing values are very low.

DRYING THE CONCENTRATES.

The concentrates made are in a very fine state of sub-division and very frothy; filtration was tried as a means of getting rid of the water, but proved a failure without the aid of presses or vacuum plant. It was found, however, that by running the material into a tank and spraying the surface, the froth was broken up; the introduction of a baffle board at the overflow end of the tank caused the mineral to settle and allowed an overflow of clear water. There are two of these tanks in use, and the concentrates are settled in each one alternately, the water is run off as closely as possible, and the wet concentrates then shoveled out on to a drying floor, heated from underneath, and from there,

when sufficiently dry, into bins ready for bagging.

The plant has now been in successful operation for six months, the mill recoveries from July 29th, 1911, to January 27, 1912, inclusive, being as follows:

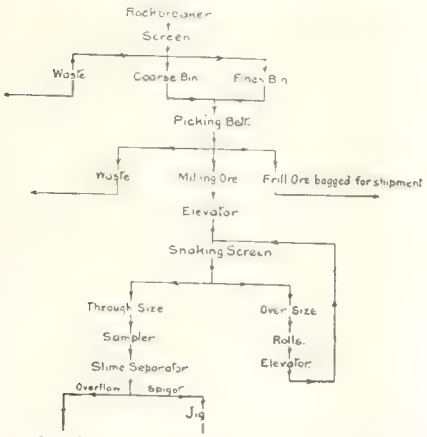
Tons ore treated	7855.00
Tons of copper contained	411.97
Assay value of ore %Cu.	5.24
Tons concentrates made	1562.00
Tons of copper contained	335.79
Assay value %Cu.	22.65
Extraction %Cu.	83.36

The recoveries are those for the whole of the concentration plant, and are worked out from the weights and values of concentrates made and shipped as against the daily assay of the mill feed. The actual recovery in the flotation plant apart from the jig is approximately 80 per cent on a 3.5 per cent feed and the assay value of the flotation concentrate is over 25 per cent copper. It is as well to state here, that it has been proved by experiment that the extraction could be increased up to 92 per cent or over, by lowering the grade of the concentrates, but, as already explained, owing to the high transport charges, there is more profit in making the higher grade product even though doing so involves making a smaller recovery.

No 1 Flow Sheet

From Rockbreaker to Jig

which is the same for all arrangements of the Mill



In order to demonstrate this clearly, the following figures are given for 100 tons of ore:

The costs of transportation per ton were as follows:

Cartage to railway station	£1 12 6
Trainage to smelting works	0 13 10
Agency and sundry charges	0 1 6
Bags and bagging concentrates	0 7 2
Total per ton of concentrate	£2 15 0

The feed in both cases is taken at 5.24 per cent copper.

1st case.

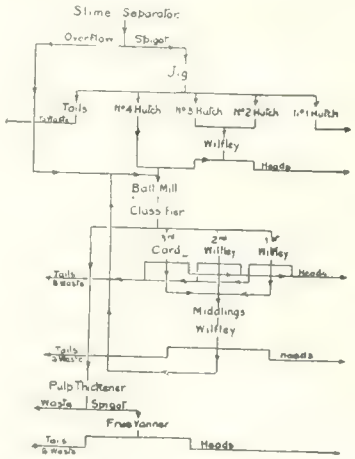
Making an 86 per cent recovery with a 22.6 per cent concentrate as at present

86 per cent of 5.24=4.5064 tons copper, and 4.5064 tons copper=19.94 tons of 22.6 per cent concentrates.

Copper is taken at £60 per ton.

No 2 Flow Sheet.

Shewing wet concentration lay-out as adopted in the original Mill.



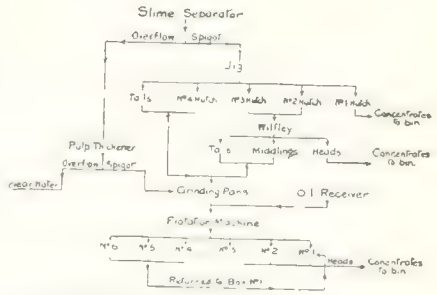
Returning charge on 22.6 per cent material is 2s 7d. per unit, with 1.3 per cent deducted from assay value.

Then 22.6—1.3 = 21.3×19.94 = 423.33 units copper.

423.33× (12s.—2s. 7d.)=9s. 5d.	£199 6 4
Deduct 19.94+3% moisture=20.54 at £2 15s.	56 9 8
Net return	£142 16 8

No 3 Flow Sheet.

Shewing first lay-out of Flotation Plant



2nd case.

Making a 92% recovery with a 19% copper concentrate:

92% of 5.24 = 4.8208 tons of copper, and 4.8208 tons copper = 25.37 tons of 19% concentrates. Returning charge for this grade is 2s. 9d. per unit.

Then

19—1.3=17.7×25.37=449.05 units copper, and 449.05×(12s.—2s. 9d.=9s 4d.) £207 13 8

Deduct

2537+3% moisture=26.13 tons at £2 15s 71 17 2

£135 16 6

or a difference in favor of the lower recovery and higher grade concentrate of £7 0s. 2d, equal to 1s 5d. per ton of crude ore of 5.24% original value in copper. It is thus clear that under the conditions existing at Kyloe it is essential to keep the concentrates to as high a grade as possible, even at the cost of sacrifice in the recoveries.

COST OF RUNNING FLOTATION SECTION.

The actual cost for the twenty-four weeks from July 3rd to December 16th, 1911, were as follows:

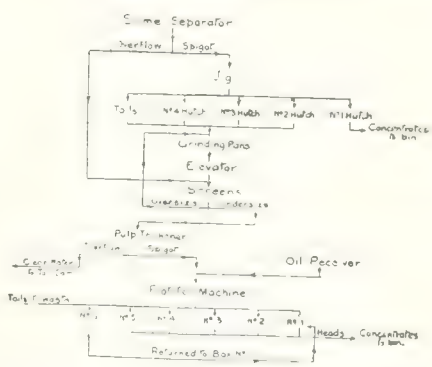
Ore milled 8556 tons. Residues treated, 5732 tons.

	Per ton of Ore Milled s. d.	Per ton of Residues Treated. s. d.
Re-grinding, screen and flotation	1 3.6	1 11.2
Power	0 2.3	0 3.4
Drying and handling concentrates	0 3.8	0 5.7
Maintenance and renewals	0 6.6	0 9.8
Assaying, lighting, etc.	0 2.3	0 3.4
Water supply	0 3.4	0 5.1
Superintendence, proportion of management and office expenses	0 2.1	0 3.3
	3 0.1	4 5.9
Royalty	0 6	0 9
Total cost	3 6.1	5 2.9

The royalty paid is saved by the Kyloe company in the lesser returning charge

No 4 Flow Sheet.

Shewing present arrangement of Flotation Plant as now in successful operation



from the smelters due to the higher grade of concentrate made.

During the first three months of this period a portion of the jig residues were run to waste, as owing to the want of power the pans could not take the whole of them; this has since been remedied and the cost per ton of residues treated

is now only about 10% over the cost per ton of total ore milled.

These costs include the re-lining of the stirring boxes with iron liners in place of the wooden ones originally put in, and also some alterations to the pans, which makes the item "Maintenance and renewals" appear high. The cost of oil, which is included under (1) is 5.2d. per ton of residues treated, or 3.5d. per ton of ore milled.

The total cost of milling for the period, including crushing, belt picking, jigging, re-grinding tails and flotation, together with all maintenance costs and proportion of management and office was 7s. 8.7d. per ton, and the cost of delivering the ore from the mine to the mill bins was 3.3d. per ton.

The mine being a small one, the tonnage available for treatment is also small, i. e., 60 tons per day, and costs are therefore higher than they would be on a large tonnage, but owing to there being no acid required, no heating of solutions, and to the more favorable conditions existing at Kyloe, the flotation costs are considerably lower than they are at Broken Hill, where the process is worked on the zinc-lead tailings.

The cost of plant will necessarily vary with local conditions, but owing to the very small space occupied and the simplicity of the apparatus employed, it will probably cost 25% less to install than a corresponding wet dressing mill with tables, slime plant, etc.

CONDITIONS FOR SUCCESSFUL WORKING.

So far, present experience indicates that any clean sulphide of the metals can be treated if the physical conditions are right; these are:

(1) That the particles must be clean and free from oxidation.

(2) That the gangue must not be of so clayey a nature as to form a fine slime which coats the surface of the sulphide particles and prevents their attaching themselves to the bubbles formed, or which in itself forms too large a proportion of "gangue slime" which comes up with the froth and destroys its holding power for the sulphide.

(3) The material to be treated requires to be ground as evenly as possible; the best size has to be determined on each individual ore.

(4) The feed and speed of the stirrers must be correctly proportioned and kept as even as possible.

(5) The thickness of pulp fed into the machine must be regulated and kept as even as possible.

(6) The minimum amount of mineral required to be present in the ore has not yet been determined; at Kyloe it amounts to approximately 10% of weight of the ore, and this gives excellent results. Experiments are now being made to determine if possible the minimum amount allowable; any excess can, of course, generally be removed by jigging or some other form of concentration before flotation.

In some cases the addition of clean pyrites may be beneficial, but as the successful float depends largely upon the total quantity of minerals, rather than the percentage in the ore, it is in many cases possible, by keeping it back in the flotation chambers, to treat successfully very low-grade material. This must, however, be tested on each ore separately.

(7) The water used has a marked effect on the process, and necessitates modification according to its hardness and chemical constituents, but a bad water is not necessarily detrimental to the working of the process.

The machines as now used are a great improvement on the old type of pointed boxes, and will no doubt be further improved upon as experience suggests modifications.

The grinding of the ore to prepare it for flotation may be done in nearly any form of machine, provided that it does not make too much slime, although the process can work successfully with a considerable quantity. The best type of machine is one which screens off the material as soon as it is crushed and returns the oversize back again. The ideal to be aimed at is to keep the particles as nearly of a size as is practicable.

In the foregoing pages the poor success at the first starting of the plant has been dealt with rather fully, for the reason that the experience gained therefrom may be of use to others when starting on a new plant, and the following up of the various causes of trouble may assist in locating weaknesses in other installations.

In conclusion, the writer would state that the Kyloe company are very largely indebted to Messrs. Faul and Lavers, the engineer and chemist respectively of the Minerals Separation Company, for the ultimate success of their plant.

———o———

The strike at Ely is over and some 2,000 men have returned to work. All this trouble, loss and expense might have been avoided if the managers had been wise and given their men a reasonable raise soon after copper went up, as was done at Butte and some of the other large camps. The "ounce of prevention" is nowhere more valuable than in the matter of labor disputes—Pacific Mining Journal.

Any machine, such as a concentrating-table, which rejects certain material, is not fairly treated if that product is returned to it. If a middling product is rejected let another machine deal with it.

———o———

In the early days of Cripple Creek a man came down from the mines to Colorado Springs, and a friend meeting him on the street said: "Well, how are things up at the Creek?" "O!" said the miner, "the miners are looking for the gold where it ought to be, and the tenderfeet are finding it where it is."—Ex.

———o———

A dividend of 12½ cents a share has been declared by the Nevada-Douglas Copper Company, payable February 1, books closing January 10. This is the first dividend paid by any of the mines in the Yerington or Mason Valley districts, and amounts to $125,000.

———o———

A local brokerage firm in a recent "market letter" offers the following profound advice: "A profit once made is sure and should always be taken. The man with a well balanced mind is satisfied with a profit of 25, 50 or EVEN 100 per cent." Yes; and when it gets around to us, we want to say that we should think a man ought to be satisfied with 100, 75, 50, or EVEN 25 per cent profit.

———o———

Need for a general knowledge of mineralogy by working miners was evidenced recently by the discovery of a six-inch seam of scheelite at the Lady Rose mine, Victoria, Australia. The miners regarded the material as worthless, since there was no indication of gold in it, and large quantities of it which had been broken were discarded as worthless. A visiting engineer recognized the material as scheelite, of remarkably good quality, worth $400 per ton, much more than the gold-bearing quartz the miners were seeking.

———o———

Original, or "makeshift," methods of doing things can be seen and heard almost every day in the copper mines of upper Michigan. William was up in the stope at a freshly broken face, from which place he called to Tom, standing on the level, "Tom, ist there?"—"Ase, ase wat do 'ee want?"—"Go up top and fe'ch down bit stull"—"'Ow long of a stull do 'ee want?"—"A midlin' long un"—"Can't 'ee measure 'im?"—William measured in his own fashion and called back, "Tom, the bit stull I want 'e dha measures as long as a pick an' a pick 'andle, a gad an' a gad 'andle, taw bluddy wedges an' a big flat rock."

Mines and Methods

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CONTENTS:

Elsewhere in this issue of Mines and Methods will be found the descriptive article of Miami mines and concentrating plant. Aside from its general technical and educational value to the engineer and milling expert, it contains much information that will interest the investor. In the closing paragraph, for instance, the author, Mr. James O. Clifford, calls attention to the method by which the mill management seeks the aid of every man about the plant in securing the best results. There is no concealment; the right hand at the Miami is not afraid to let the left know what conditions are, and as a result all hands work in harmony with a determination to make the best possible record. At the Miami the men have confidence in their employers and the employers repose the utmost confidence in their men. Such a condition augurs well for the shareholders for it is evidence that those charged with the mining and milling operations of the company are not afraid of honest publicity, either at or away from the works.

"Stupendous Undertaking" of Utah Power & Light Co.

From the over-zealous tone and effusive utteamces of the subsidized reporters of the local and Boston daily papers it is quite evident that some further financing stunts are shortly to be undertaken by the promoters of the so-called "stupendous undertaking"—the new Utah Power and Light Co. This latest publicity scheme pictures the multiplied "young millionaire" who occupies the company's chief office as contemplating the early electrification of all the great intermountain railroad lines in addition to supplying cheap power and light to all local users, while the farmers are to be similarly supplied with sufficient power to operate pumps enough to bring under cultivation all of the arid lands of the entire West.

This is most certainly a cheerful picture and we expect that announcement will soon be made that all that remains to carry this benevolent purpose into effect will be public subscription to an issue of $60,000,000 of convertible bonds; or, possibly for the present, the activity may have for its purpose only the completion of the financing of the $40,000,000 capital which forms the present basis of this dazzling enterprise. The purpose of this corporation, as announced to the public is, as a holding company, to take over certain independent operating companies located in Utah, Idaho and Colorado, and thus far it appears that every independently operated plant in the states named have been practically assembled and the ownership lodged in the holding company.

When we remember that all these plants were practically being operated at capacity of their resources and that their product was being marketed and consumed, it is difficult to conceive just how the combined plants will be enabled to enlarge their outputs sufficiently to provide the necessary energy to supply the demand of the enormously enlarged field of industry that comprehends the reclamation of all the arid lands of the West, the operation of the railroads, etc. Besides, the Utah Copper Company, on abandonment of its steam plant, becomes a preferred consumer of 15,000 to 20,000 horse-power which must be drawn from a supply already taxed to the limit.

It also is a fact that for some weeks prior to the announcement of the combination employes of the individual companies were actively engaged in soliciting extension of existing contracts for a period of years on the pretense that the growing demand was such that it would be difficult for regular patrons to secure a continuation of the regularly needed supply of power. And it is pertinent to observe in this connection that no reduction in price was offered, which price, in the case of small consumers, afforded a profit of anywhere from 100 to 150 per cent over the cost of production, the limit being just sufficiently below the cost of securing the energy from coal, together with the convenience that attends the handling of electric power, to make the latter preferable to the consumer.

With these facts before us we see little encouragement to the prospective farmer to undertake to secure a tract of these desert lands with a hope of securing cheap water for irrigation by means of electric power to be supplied by this benevolent combination. Stripped down to cold bedrock this corporation, with its magnanimous pretenses, in addition to the useless $1,500,000 steam plant of the Utah Copper Company, (soon to be abandoned), has succeeded in securing all of the independent, live, operating, cheap power-generating plants in three states at a cost probably not exceeding 30 per cent of its enormous share-capital, the balance being "velvet," and upon all of which the consumer must be so taxed as to afford an acceptable interest rate, for it must not be expected that rates already covered by contract will be reduced pending such contracts, or in the absence of an offer of competitive power at lower rates. And the demand for additional capital—under some pretense or another—will come just the same, whether any more available water power sites remain or not; and it will be interesting to note in what form the demand is made for additional public money when it comes.

GETTING READY TO "SOAK" THE PUBLIC

The Salt Lake Tribune of December 24 quotes Thompson, Towle & Co., on the Alaska Gold Mines fake as follows:

We have been looking over [illegible] reports of the Alaska Treadwell Gold Mining company, in an endeavor to compare costs of mining there with the claims of a 75-cent mining and milling cost for the Alaska Gold Mines, and the conclusions would appear to be very much in favor of the Alaska Gold Mines company as to ability to mine and treat a ton of its ore for 75 cents per ton.

In the case of the Alaska Treadwell its total mining cost for 1911 was $1.0699 and its total mill cost 2.72 cents for its 240-stamp mill, and 18.20 cents for its 300-stamp mill.

There is no question but what the Alaska Gold Mines company, with its new, big 6000-ton mill containing the latest machinery, will be able to mill as cheaply as the Alaska Treadwell, but even allowing a 25-cent cost for milling, a total 75-cent cost would leave 50 cents for mining and delivery of the ore to the mill.

In the $1 cost of the Alaska Treadwell for mining, are the following, to wit:

Machine drilling	.2685
Laborers	.2090
Power	.1816
Steam power	.1114
Total	.7805

Practically the greater part of this expense will be avoided in mining the ore bodies of the Alaska Gold Mines company, the ore being friable and breaking in immense masses, requiring little in the way of underground machine drills and power, and after the ore is once broken all other operations are practically automatic, therefore the labor costs are comparatively small. The power is developed from the company's own 5000-horsepower hydro-electric plant, so that the only cost on this item is interest on investment and upkeep of a few dollars per horsepower per annum.

It is therefore safe to say that at least 60 cents of the total $1 cost of the Alaska Treadwell company will be saved to the Alaska Gold Mines company in its proposed system of treating its big masses of low-grade ores.

As a matter of fact, in allowing an estimate of 75 cents for mining and milling this ore there was a leeway of at least 10 cents per ton given, and the management has anticipations of actually being able to mine and treat a ton of ore for 50 cents, which would leave a net profit of $1 per ton, allowing the ore ores only averaged $1.50 per ton. But even in that respect we understand the values are underestimated about 75 cents per ton.

What drivel; what sorry rot! What straits a combination of loudly touted "world's greatest engineers" must find themselves in to permit such stuff to go out to the public. If there is any part of this presentation of the Alaska Gold Mines scheme that does not savor of fraud and dishonesty we should like to have it pointed out to us. There are some pretty bright men connected with the Thompson-Towle concern and it is inconceivable how they could bring themselves to father such statements. We had credited them with having at least some regard for their standing and reputations among men; and we dislike to believe, even now, that they have not been imposed upon.

With large mining interests and promotions of their own in different parts of this country; with a corps of capable engineers of their own constantly at work and in personal touch with every feature of the best mining, milling and smelting practice in mining regions everywhere, it would be a sad reflection on the intelligence of the personnel of the firm mentioned to intimate that they believed anything contained in the article quoted above. They know, for instance, that with all the advantages of cheap labor, perfect railroad facilities, ideal mining conditions and every other factor that goes to make for low cost records, none of the mines and mills operated in Utah, Nevada, Arizona, New Meico and Montana, by the men who are directing the destinies of the Alaska Gold Mines Company ever have been able to mine and treat a ton of ore for anything like 75 cents—a figure which Thompson, Towle & Co., declare is likely to be lowered to 50 cents a ton in a glacial, precipitous, wild region several miles back of Juneau, Alaska.

The statement quoted undertakes to make a point of the fact that the Alaska-Treadwell mining cost was nearly one cent over $1 per ton; that 78.05 cents of that amount was chargeable to machine drilling, power, labor and steam power; that most of these costs will be avoided by the Alaska Gold Mines, "the ore being friable and broken in immense masses, requiring little in the way of underground machine drills and power."

Of course the investing public might not stop to think about it, but Thompson, Towle & Co. knows that if the ground is soft and friable enough to mine and break down in "immense masses" without the aid of powder or drills, it will cost a great deal more to timber and make safe the underground workings than the costs referred to for power and drills could possibly reach. Thompson, Towle & Co., also know that while the Alaska-Treadwell puts its ore through several processes (concentration, amalgamation and leaching) and yet works the cost down to a trifle over 22 cents a ton as an average, the best record the Utah Copper Company's management (with its unapproachable (?) skill and limitless resources) has been able to make at its widely heralded "perfect" mills has been—using their own figures for it—42 cents a ton; and that cost record is produced in plants wherein nothing but the one process (that of simple concentration) is employed, and this upon an ore exceptionably friable and pulverulent.

It is simply impossible to believe that Thompson, Towle & Co. have any faith in the ability of the Utah Copper management—which is doing the engineering for Alaska Gold Mines—to cut even close to making a legitimate profit out of the stuff they are pleased to call ore at that company's properties.

If readers of Mines and Methods will take the trouble to again read the original report of Messrs. Jackling and Holden upon the Alaska Mines and then follow through the comment and criticism of this publication, they cannot fail to see that every effort now being made to bolster up the proposition has been called out by our exposures of its utter worthlessness and present exigencies of the case. The "great engineers" mentioned above promised that $4,500,000 would cover development and equipment costs, including a 6,000-ton mill; but inside of four months after making that declaration, we hear it told that the company is contemplating the early issuance of new stock at $20 or $25 a share, to back a convertible bond issue.

Now this makes it plain, does it not, that the public did not take the original stock to any appreciable extent, and that if $4,500,000 was raised it came from insiders. If that is the case, what is more natural than that the gentlemen who have thus far been taking care of requirements should still want their money back and what is more natural than to "sand-bag" the public for it?

Within the next ninety days we expect reports from Alaska Gold Mines promoters to show that the Sheep Creek tunnel has demonstrated that the Perseverance ledge—originally thought to have been the chief ore-bearing channel, is nothing more than one of the lines of demarkation to an ore-bearing zone amounting to practically "a mountain of gold," and that the gullible Thompson-Towle outfit will be used to diffuse that information and help round up the public's coin in exchange for convertible bonds.

[Note: Since the above article was written the subsidized press has actually commenced likening the Alaska Gold Mines to the Utah Copper.]

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A facetious member of the staff of the New York Sun has asked why Mr. Untermyer, who is conducting the money-trust investigation for Mr. Pujo, does not put himself on the stand and ask himself to explain all the details of the Utah Copper-Boston Consolidated amalgamation.—"By the Way" man in E. & M. Journal.

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Tin has been discovered in the province of Alacania, Chile.

SAM. NEWHOUSE GOES ABROAD

After about two years of involuntary silence on his part and an almost cruel withdrawal of his publicity agents, announcement was made early in the month that Samuel Newhouse was leaving for Europe, where he would spend a couple of years in rest and recuperation.

How time flies! And what mighty changes are wrought in the sweeping by of the allegorical character symbolized by the hour-glass and scythe! How pitiless is fate; how unrealistic is the glare of the modern "spot-light," and how deep must be the gloom one feels when that light is shattered and the realization comes that a selfish world no longer worships!

The passing of Samuel Newhouse from the stage of mining promotion activities and the field of business enterprise in which he swirled with such dazzling brilliance for a few brief years borders on the tragic. He shot into the firmament of fame like a rocket, spent his force, exploded in mid-air, and then—oblivion enveloped him, and the world forgot. His rise furnished material for thousands of pages of worldly newspaper comment and sycophantic laudation; his descent and exit has brought forth no words of comfort or even regret from his erstwhile friends. Why is it?

Mr. Newhouse's career as a mining promoter and "magnate" was, for a time, most successful. Glancing back over the record and comparing it with history now being made along similar lines and with even more lavish and extravagant detail, the thought will not down that other "master minds" in the speculative mining world also are heading their crafts direct for the sea of oblivion and the ragged shoals of "investment" ruin. Like Newhouse, they personally may retire in comfortable circumstances, but their gain will only add to the wreckage strewn along the path of those who follow them. To those who would take the lesson home it should only be necessary to call attention to one of the schemes worked by Newhouse in order that it may, by inference at least, be compared with others of much greater magnitude and boldness now being perfected for those who are confidently counted upon to follow blindly the "bull" leader in his march to the slaughter house.

Mr. Newhouse accumulated not a little of his money through the exploitation of the Newhouse Mines and Smelters, and much of it came out of the pockets of Utah people. Thousands vividly recollect how Mr. Newhouse flew across the continent and landed here just in the nick of time to rush to the bank and plank down $200,000 on an option that covered the chief property in Beaver county that was to form the basis of the corporation. Then followed the organization of the company, the equipment of the mines and the building of mills and power plants; the purchase of springs and the installation of water works; the building of the town of Newhouse, with its modern club-house, together with a railroad from Newhouse to Frisco, so that no impediment should be placed in the way of the prompt opening up of the mammoth orebodies and the marketing of the product. The old mine workings were connected through a long, new operating tunnel, when it was quickly discovered that acres of copper ore broke through to the surface. This ore could all be scooped up with steam-shovels, dropped down through the shaft and loaded in trains at the

Samuel Newhouse

tunnel level and from there be sent direct to the mill. Through the inauguration of this scheme Mr. Newhouse became the pioneer steam-shovel miner of copper ore in Utah.

Following this loudly and widely heralded preparatory campaign came that of the real business—the manipulation of the stock market and the unloading of insiders on the public. Everybody remembers what happened to them, even if they don't know just HOW the scheme was worked. The mine developed in a "phenomenal" manner; there was strike after strike and reporters, stock brokers and the public was loaded to the guards daily—often hourly—with the latest reports from the property, the press notices being usually accompanied by a photograph of the promoter. It was glorious! Finally the market price of the shares began to climb, then to soar, and everybody made money—on paper.

To help out the situation the price of copper metal also began to soar, so all hands loaded up with Newhouse Mines and Smelters stock. The boom started around $4 a share and it broke at about $26. The public got in at about $9 a share up. Mr. Newhouse was reported as having reluctantly surrendered 100,000 shares of his personal stock in one block to French investors at about $20; it was just like making the Frenchmen a present of about $20 a share; he was morally certain that the stock would go to $40, because it was worth much more than that.

Well, it was not long until the public became inquisitive, if not suspicious, and wanted to know more about the value and extent of the orebodies in the mine, the character of the stuff being milled and the recoveries made. Committees of stockholders were frequently organized to visit the mine and see for themselves, and—as most of them knew little about mining and the reduction of ores—it was not hard to "show them" what a big thing it was. These committees usually returned greatly elated by reason of what they had been told and "shown" and—bought more stock. The price of copper metal, which had touched 26c., then began to recede as if in an effort to keep pace with the decline in Newhouse shares, already started. Then came the effort to stem the tide of the receding current by the announcement that the company would begin paying regular dividends in the immediate future; but the thing was top-heavy, and soon the inevitable reaction set in. The decline was gradual at first, but certain. While the "investors" were patiently waiting for the dividend period to open insiders were "shorting" the stock and making additional large profits, because they knew what mine conditions were and that the $300,000 with which to pay the initial dividend would have to be borrowed. Hundreds of people here in Salt Lake paid from $16 to $26 a share for Newhouse stock, held it for dividends, received 50c a share and finally, later, were permitted to stay in and participate in the reorganization of the company on the payment of an assessment of $1 a share, half of which reimbursed the lenders of dividend money while the remainder provided a working fund for the new company.

The situation today is about like this: The old company was taken over by the South Utah Mines Company, which increased the original shareholdings of the Newhouse Mines from 600,000 to 850,000, par $5. The new company negotiated a bond issue of $1,000,000, convertible into stock at par and $800,000 was used to retire the bonds of the old

company; the remainder, as we understand it, to be used in so equipping the property that it might be made self-sustaining.

It should here be mentioned that in a previous issue of this magazine it was shown that of the entire volume of ore passed through the mill under the Newhouse regime there was an actual loss on operating account of 68c a ton, in addition to the entire loss of the output of the mill and mine. Subsequent reports of the South Utah Mines Company show that the same practice and loss has continued and that, in this manner, has been absorbed and wasted the entire working capital of $260,000 left over from the $1 assessment of the old company.

The old company never was able to earn a dollar, and it is evident that the new one is now face to face with the futility of the struggle and is ready to quit. It is hopelessly in debt and the holders of the "convertible bonds" begin to appreciate that these new-fangled modern "securities" are possibly not always what they seem.

It is not believed that many of those who acquired an education in high finance mining through their connection with Newhouse propositions are taking much stock in the more nearly up-to-date schemes of Newhouse imitators; nor should it be required of us to warn anybody that the Newhouse schemes were as kindergarten performances when compared to games now being played.

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"SMOKE NUISANCE" COMMENT

Ed. Mines and Methods: Remembering Salt Lake City only as it was in the seventies, especially as I saw it, usually in April, hidden under clouds of peach and apricot blossoms with the pure, undefiled breezes sweeping over it, amidst the clear Western sunshine, your article on the smoke nuisance comes as a shock to me. It is indeed a calamity to have so beautiful a city as Salt Lake then was—a joy to the beholder—turned into a "modern city."

My object, however, in writing is to call your attention to something that will mitigate a part of the nuisance. Nothing but rooting out the smelters will prevent the gases from their furnaces which are far more objectionable than the visible smoke, but the smoke from power plants or all plants where coal is burned on boiler grates can be entirely done away with by the use of a new system of burning coal, the use of mechanical draft and of the Grieve grate, which Mr. Albert Richter, an engineer of your city, can give further information on. This grate simply produces perfect combustion—an incandescent, smokeless fire—and in its turn produces a very great economy in fuel, rarely less than 20 or 25 per cent and often more, so that an installation is earned in the superior economy usually in from one to three months, depending on now many hours a day the plant runs. None of these grates have yet been installed, but why is not this feasible? Two or three interested parties find some one who can install and prove these claims and when you are convinced—as you will be—that smoke cannot only be prevented but doing so will be an investment for the owner of the check book that pays for the coal of several hundred per cent per annum, then pass a stringent smoke ordinance and if necessary shut up plants that continue to be a nuisance.

The grate in question has only been on trial for four years and only last fall put on the market; but aside from fuel economy has shown such merit that it is being bought where coal has practically no value, such as the culm at the mines. Such concerns as the Standard Oil Co. have many hundred of them in their refineries, while the Corn Products Co., American Sheet Tin Plate Co., American Steel & Wire Co., and any number of other large and well managed concerns are using this grate. I could enumerate numbers of equally important buyers, but mention only a few to explain that this is no fad or untried thing. I want to add that I have not a cent's worth of interest in whether they are sold or not in your state; but once convince one or two of the right kind of people what this means and self-interest will make the fight an easy one.

The owners of the large dry goods and mercantile establishments lose annually enough in value of merchandise so they could afford to equip every plant in the city.

I am very much interested in Mines and Methods, although not a miner, and have several times had occasion to warn others as the result of what you have cautioned your readers to beware of.

Yours Truly, CHAS. L. MANN.

Milwaukee, Wis., January 21, 1913.

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Copper producers have relieved themselves of the strain they professed to be making to prevent "a run-away copper metal market" by lowering the price more than a cent a pound. It is now in order for the manipulators of Utah Copper to begin explaining how much easier it will be to increase dividends with the metal at 15c or 16c than it would have been had the price been held at 17¾c or advanced to 20c. Geo. L. Walker probably can make the "argument" as well as anybody.

Cable advices received from Chile, says a New York publication, state that important development work has been done at the Braden mines recently. In the Teniente mine an extensive deposit of copper ore has been uncovered, averaging 5.35 per cent. copper, as compared with copper ore mined recently at 2.70 per cent. The mineral separation plant which has been put into full operation within the last few weeks, has shown a recovery of 81.60 per cent of copper, as compared with 62 per cent of recovery in the old mill. In the early part of next year the Braden company will have its full equipment in operation, and engineers and officers of the company claim that from 45,000,000 to 50,000,000 pounds of copper a year will be produced with the present equipment in full operation.

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This sixty-two per cent recovery mentioned is what was obtained by methods patterned after Utah Copper. The difference is practically twenty per cent in favor of the new process; and still there is daily exploitation of the "perfection" of the methods employed by the engineers of the "low-grade porphyries" companies—Utah Copper, Ray, Chino and Nevada Consolidated. According to the above item concerning Braden, the other companies mentioned might just as well be recovering one-fifth to one-quarter more copper than they are doing at present. In other words Utah Copper, for instance, is WASHING AWAY into the tailings ponds about ONE-HALF AS MUCH COPPER in a year as Braden makes. The wonder is why do the Guggenheims stand for it!

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Commenting on a statement that "Producers are endeavoring to supply the current demand for copper without a further advance in price," the American Metal Market Report recently observed: "This last statement seems a strange one to make. To most of the trade we think the impression is that the producers are not trying to stop prices from further advancing, but trying to stop prices from declining, as a result of the certainty of larger increased stocks to be shown in their next statement and the threatened situation abroad. This, however, is no criticism on the power of the producers to hold prices from declining. We believe this is something that is easily in their power for some little tome to come, irrespective of developments."

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After three months devoted to pressing professional work Mr. W. L. Austin is again taking up the presentation or his papers on "Leaching Applied to Copper Ore." His article intended for this issue, however, arrived too late to meet the necessities of press runs and must go over to next month. The forthcoming articles of the series will deal largely with features of the practice and art as it exists today, and that they will be found highly educational and intensely interesting to the profession there is no doubt.

SITUATION INVOLVING BUTTE AND SUPERIOR

The consternation occasioned during the early part of this month by the "unloading" of large blocks of Butte & Superior stock on the eastern market by reputed inside interests resulted in Mines and Methods making a thorough investigation into the causes for the flurry mentioned. The results obtained from the investigation made at the property, in part, briefly outlined in the following paragraphs, are based upon actual facts derived from a personal examination by a member of the staff. We could publish much data on the subject at this time but primarily the intent of this paper only is to outline in brief the salient features and present to those vitally interested in legitimate mining matters the true situation. We prefer that readers draw their own respective conclusions from what is here outlined, and therefrom they can readily appreciate the conditions existing at the Butte & Superior property under the present management, which is representative of the conditions existing at every property in which the Utah Copper interests are the dominating factors.

Reference has been made from time to time in the columns of Mines and Methods to the remarkable occurrence of zinc ore at the Black Rock mine in the Butte mining district, Montana. The property is controlled by the Butte & Superior Mining Company which has thoroughly prospected the orebody during the past several years and is said to have resulted in the development of a large tonnage of ore reported to carry an average mineral content per ton as follows: Zinc, 17 to 23 per cent; lead, 1 to 2 per cent; iron, 2 to 3 per cent; magnanese, 2 per cent, and copper, 0.3 to 0.5 per cent. It will be noted from the foregoing that the ore is of simple character, and of unusual grade. Contrary to many market reports the ore is not in in the true sense of complex character, and should yield readily to established methods of ore-dressing.

The Black Rock mine, more commonly termed the Butte & Superior, is not by any means a recent discovery, but has been a producing property for several years, during which period it has been operated profitably though on a small scale. However, the profits derived from the operation of the mine were, in a great measure, utilized in the further development of the property and is said to have been accompanied by successful results, as outlined by the present available tonnage of ore.

In the early history of the company financial conditions were such that the construction of a concentrating mill near the mine was a matter beyond even a remote consideration. Further, the development at that time did not warrant the erection of a mill in anticipation of underground mining development. Consequently arrangements were perfected whereby the old Copper Basin concentrator was acquired, and while the equipment was not especially adapted to the treatment of zinc ore, the engineer engaged by the company to superintend the milling operations ably arranged a plan of concentration which, in point of efficiency and economical operation, was very satisfactory; particularly as the plan considered only the antiquated equipment of the old concentrator, together with a few makeshift machines requisitioned into service.

This improvised plant was used for a considerable period of time, and beside operating to a profit, served a useful purpose as an experimental station wherein to work out a plan of efficient and economical concentration of the ore for future use. Exhaustive tests having been made at the old Basin concentrator under actual operating conditions over a long period of time an efficient and economical flow-sheet was determined which would effect an extraction of eighty per cent of the zinc mineral contained in the ore to be treated.

NEW FINANCING.

In view of the developments at the mine, and the need of a new concentrator nearer the mining property, the management entered into negotiations with Hayden, Stone & Company, through the dominating interests of the Utah Copper Company for the further financing of Butte & Superior, primarily for the purpose of securing money from the public with which to construct a fully equiped and modern milling plant based upon the best practice at Basin. The negotiations resulted in the stock control of the company passing into the hands of Hayden, Stone & Company, and the Utah Copper interests. The property thereafter entered the field more as a stock market issue than as a legitimate mining promotion, and naturally Mr. D. C. Jackling was appointed managing director of the company.

Capital for the construction of a new concentrating plant having been supplied by the public, the concentration engineer who had so successfully operated the Basin mill with good results under the most adverse conditions, was instructed to design a new concentrator the flow-sheet to be worked out upon the lines of the treatment which had proved so highly efficient and economical at the old Basin concentrator, and to submit the plans of the proposed new plant to Managing Director Jackling.

In compliance with this instruction a new concentrating mill of two 600-ton units was planned, designed, and completely built and equipped, all with the absolute approval of Manager Jackling. This new mill considered a treatment plan which had previously been worked out under actual operating conditions, and that readily would effect an average recovery of eighty (80) per cent of the zinc mineral in the ore to be treated, when operations were conducted on a basis of unit normal tonnage. In design and equipment the new mill was a credit to the constructilon engineer. Further it was fully adapted to at once fulfil its requirement, and was designed not only to treat the unit normal tonnages and effect a maximum recovery of the zinc values, but could perform its duty under constant operation, without any necessity for remodeling.

Immediately following completion the new concentrator was prepared for a trial run, so that the numerous mechanical difficulties attending the starting up of new machinery could be remedied. The only obstacle in the way of trying out the ore-dressing efficiency of the concentrator was a shortage of water. However, in view of this last named adverse circumstance, arrangements were made so that the jigs treating the coarse feed, and which were an essential part of the milling equipment of the unit, would be eliminated from the test, as water for only a portion of the unit was available. Therefore, the concentrator was started only in part, and operated for a period of about twenty hours, during which time, however, the efficiency of the equipment was demonstrated to perfectly fulfil every requirement, though the run was not representative of what would have been accomplished had every section of the unit been placed in operation. Notwithstanding the curtailment of operations, that portion of the equipment operated during the trial run clearly indicated that its complete unit efficiency readily would afford a general average recovery of eighty per cent of the zinc mineral contained in the ore to be treated, providing the entire equip-

ment was operated in unison and conditions normal generally.

REMODELING OF MILL BEGINS.

At this point in the operations a peculiar circumstance intervenes which is especially interesting in view of that which has been stated hereinbefore regarding the authority for, and approval of, the original mill design and construction. Messrs. Jackling and Janney, after the above mentioned indicated efficiency of the concentrator on the very brief test mentioned, promptly decided that the mechanical arrangement of the new plant did not conform to the popular standard.

They thereupon immediately proceeded, under the supervision of Mr. Janney to remodel section 1 of the mill, which they completely rebuilt in accordance with the general flow-sheet plan prevailing in the Utah and other mills under their supervision. Section 2 at present is being stripped of its original equipment preparatory to a duplication of the remodeled unit 1. By the time the remodeling of the second until shall have been completed the same course shall be followed as that which has prevailed at the Utah Copper, Chino Copper, Ray Consolidated Copper; that is, section one will be in line for further modeling of that remodeled section, and so on, ad infinitum.

Before treating the subject in detail attention is called to the fact, as hereinbefore stated, that Manager Jackling had approved the plan, design, and construction of the original new Butte & Superior concentrator (which was based upon the best practice at the old Basin mill), and immediately following its completion and initial trial run, had condemned the flow-sheet as inefficient, and at once ordered the concentrator stripped of its original equipment, and rebuilt along the lines of the remoledel Arthur plant of the Utah Copper Company. There is a reason which will be apparent to readers when they have carefully read the following paragraphs, incidentally it is an explanation of the present ruling stock market situation which has brought about the disposition of large issues of stock from reputed inside interests.

The mechanical inefficiency occasioned through the remodeling of the new Butte & Superior concentrator perhaps is best illustrated by a strict comparison of the results obtained through the operation of the remodeled mill, and those resulting from the operation of the old Basin mill, at while latter place no pretence was made that mechanical perfection was, or could be attained in view of the many adverse conditions under which operations had been conducted. Let it suffice to state, however, that an ore-dressing expert had charge of the Basin concentrator, a fact that will be more pronounced when a strict comparison of results is made between the two milling plants. On the other hand Manager Jackling and has associates had claimed also the adoption of their ideas of ore-dressing the zinc ore from the Butte & Superior mines would result in the recovery of 80 to 85 per cent of the zinc mineral contained, besides greatly increasing the tonnage handled. The circumstances demand a comparison of the results obtained from both the old Basin mill and the recently remodeled Butte & Superior mill.

TABLE OF COMPARATIVE RESULTS.

Milling Plant	Month	Tons Ore Milled	% Zinc Heads	Tons Concentrates produced	% Zinc in Concentrates	% Zinc recovered	Cost per ton Ore Milled
B. & S. Remodeled Mill	Nov. 1912	12,339	19.1	2,808	46.8	56.7	$3.65
Old Basin Mill	Nov. 1911	13,010	22.0	3,000	50.1	60.5	$1.98
Difference		—671	—2.9	—192	—3.3	—3.8	+1.67
B. & S. Remodeled Mill	Dec. 1912	16,456	18.9	4,058	46.2	60.6	$2.89
Old Basin Mill	Dec. 1911	16,890	20.9	4 315	50.2	61.6	$1 92
Difference		—454	—2.0	—257	—4.0	1.0	+0.97

COMPARISON OF MILLING RESULTS.

For convenience the table given herewith clearly outlines the results obtained at the old Basin mill during the months of November and December, 1911, and those of the remodeled Butte & Superior mill during the months of November and December 1912. The figures given were in both instances derived from the company's records and therefore represent the actual operating conditons during the periods mentioned.

It will be noted from the table of comparative results given above that the remodeled Butte & Superior mill under its direction by Manager Jackling has failed in several vital particulars. Further, no evidence of increased unit tonnage treatment, or the promised high percentage recovery of the zinc content of the ore is apparent on the company report given above, though the mill has now been in operation under the new process for more than two months.

Stockholders in the Butter & Superior Company need not anticipate that a maximum percentage extraction of zinc mineral will ever exceed the December, 1912, figures until the present management shall return to the safe and sane methods of operation as embodied in the concentrator as originally constructed. It is quite certain, however, that increased unit tonnage at the expense of serious loss of mineral will be a predominating feature of the milling operations at the plant in the future, and for the benefit of those who are not conversant with the plan of treating tonnages of ore far in excess of rated mill capacity, it should be remembered that, for every per cent increase of tonnage treated over normal unit capacity there is a resultant loss occasioned which bears almost an inverse ratio to the percentage of excess ore treated.

In this connection it is pertinent to observe that the highest estimate made by the able engineers who have calculated the total actual tonnage of ore of commercial grade developed does not exceed two million (2,000,000) tons, which, at the normal rated capacity of the present Butte & Superior concentrator (1200 tons daily) affords supply for less than five years. Further, the former management during the progress of prospecting the territory controlled by the company exercised every possible means of locating additional ore-bearing areas by running long drifts with their attendant crosscuts from the various levels of the mine, but without successfully encountering any material of even remote commercial value. In fact, the orebody as at present delimited apparently outlines the extent of the deposit, and any further prospecting, either with depth or laterally holds no hope for the future. Possibly, therefore, the knowledge of these facts had some influence upon the action of Captain Wolvin to induce him to depart with his shares of stock in the company as recently reported from the eastern stock exchanges, and that the liquidation of his interests was not altogether involuntary.

COMPARATIVE OPERATIONS.

A brief resume of the comparative operations of the old Basin mill and the recently remodeled Butte & Superior mill is shown in the table to more clearly outline the discrepancies of the new plant operated by the Jackling management. Firstly, a comparison of the November, 1912, operations of the newly remodeled Butte & Superior concentrator is made with the November, 1911, operations of the old Basin mill. It will be noted by referring to the table that dur-

ing the month of November, 1912, the Butte & Superior concentrator treated 12,339 tons of ore averaging 19.1 per cent zinc from which 2808 tons of concentrate were produced having an average metallic zinc content of 46.8 per cent representing a maximum recovery of zinc mineral from the mine-run ore of 56.7 per cent, at a milling cost of $3.65 per ton of ore treated. During the month of November, 1911, the old Basin concentrator milled 13,010 tons of ore averaging 22 per cent zinc from which 3,000 tons of zinc concentrate were produced, having an average metallic zinc content of 50.1 per cent, representing a maximum recovery of zinc mineral from the mine-run ore of 60.5 per cent, at a milling cost of $1.98 per ton of ore treated

Therefore, it will be seen that the results obtained at the Butte & Superior mill when compared to those obtained at the old Basin mill show (1) that during the respective months of operation the old Basin mill handled 671 tons of ore more than the Butte & Superior plant; (2) produced 192 tons more concentrate, each ton of which contained 66-lbs more zinc per ton; (3) the percentage recovery represents an extraction of 16.76 lbs. more zinc per ton of ore treated, and (4) finally, the milling cost per ton of ore milled was $1.67 less. A similar comparison can be made concerning the operations for the months of December, 1911, and December, 1912, by the old Basin and the new Butte & Superior mill, evidencing throughout the higher efficiency of the former.

That a new mill, recently remodeled along the lines of the Arthur plant of the Utah Copper Company, and designed to recover 85 per cent of the zinc mineral contained in the crude ore should suffer the relapse noted from the report shown (although nursing was a particular feature of the operations throughout) and demonstrate its maximum efficiency by recovering but 56.7 per cent of the zinc mineral treated is deplorable.

Now, carefully compare the results obtained from the new mill in 1912 (as outlined in the table) with those resulting from the operation of the old Basin mill during similar months in 1911, and draw your own conclusions. Incidentally it might be advisable to compare these results with what is found in the market letters of the brokerage houses representing the Jackling interests, and also the reports made by the gentlemen who renovated the Butte & Superior mill.

Referring to the comparative milling costs for the months of December, 1911, and 1912, it will be noted that the cost in December, 1912, was reduced from $3.65 for the preceding month (November, 1912,) to $2.89. In explanation of this peculiar feature it is proper to state that the reduction in cost per ton of ore milled from $3.65 in November, 1912, to $2.89 in December, 1912, was accomplished merely by charging off to construction the difference of $0.76. In view of this evasive practice of substituting operating costs as outlined (transferring same to either construction or capital accounts) it is to be expected that within the next few months Butte & Superior will be producing zinc for nil.

Another interesting item considers the water supply for the mill. Water has always been a precious commodity at both the old Basin mill and more especially at the Butte & Superior mines where the new mill is located. Consequently, in view of the recent extensive operations, a considerable increase in quantity of water has been required and negotiations were closed with the city waterworks for the required supply. The result of this arrangement for the month of December, 1912, has been that the water for the milling operations of one 600-ton section (the other section not having been thoroughly remodeled) cost the company $5,690, in addition to the fixed charges for the water recovery plant at the concentrator. When the other section of the concentrator shall be placed in operation there will necessarily be a corresponding increase in the expense of water supply, all of which is equivalent to a very satisfactory profit in itself.

The foregoing may serve to indicate a reason for the recent heavy selling on the New York market by the controlling interests—other than those represented by Captain Wolvin as before referred to. On this occasion at least, the Jackling management has run up against a real mining and milling project which will not countenance amateur experimental milling. In short they have acquired a property that requires engineers to handle, and not a crew of gentlemen with ideas which ignore established mining and milling practice.

In conclusion our contention is that under the present management the property is being used primarily as a stock-jobbing scheme, which every move thus far made clearly proves. Further, we know that the engineer who designed and built the original Butte & Superior mill was thoroughly conversant with every requirement of the situation, and, moreover, that his plans were endorsed by Manager Jackling; also, that had the original mill been permitted to operate the results obtained would have met all reasonable expectations and the property would have come into its own Thus it would have become a highly profitable producer, though evidently not upon a scale to support inflated stock market quotations.

DEATH OF PROF. KOENIG

Inexpressibly shocked were the local graduates of the Michigan College of Mines when the wires announced, on the 15th of the present month, that Dr. George Augustus Koenig, the noted chemist and scientist and dean of the department of chemistry, had died the night before at the home of his son in Philadelphia. Dr. Koenig's last trip to the West was made during the summer of 1910, when he came out here to make a scientific investigation of the Utah-Wyoming phosphate deposits in the interests of Messrs. M. S. Duffield and L. A. Jeffs, who have, since that time, cleared up their titles to a large portion of the phosphate lands in the region mentioned We excerpt the following from the Houghton Gazette's mention of the famous educator's death:

George Augustus Koenig was born at Willstatt, grand duchy of Baden, Germany, May 12, 1841. He was the son of Johannes and Margaretha Pfotzer Koenig. His primary education was gained in the public schools of Willstatt. He studied at the progymnasium at Kork from 1854 to 1857 and during the ensuing two years at the Moravian Bros.' school at Lausanne, Switzerland. Graduating from the polytechnical school at Karlsruhe in 1863, with the degree of mechanical engineer, he entered Heidelberg university and remained there [illegible] later taking the degree of master of arts, 1867, at the University of Berlin after two years of study. He spent the year 1867 at Heidelberg, taking the degree of doctor of philosophy, and spent the next year at the mining academy of Freiburg, Saxony.

Dr. Kroenig's greatest achievements as a scientist was in the field of new minerals. He discovered no less than thirteen hitherto unidentified minerals, the following being the list: Hydrotitanite, randite, Leydite, Alaskaite, beergerite, bementite, footite, paramelaconite, mezapilite, mohawkite, keweenawite, stibiodomykite, nickel, bridle.

Dr. Koenig re-examined many known minerals and shed new light on their origin and structure and he was the discoverer of the fact that the diamond occurs in meteoric iron.

Dr. Koenig easily was the most popular professor ever connected with the Michigan College of Mines. His many years of residence in the United States had not eradicated entirely the traces of German from his spoken utterances. He realized that this characteristic sometimes gave the students occasion for laughter and he always joined in it gladly. He had a kindly humor and his lectures always were illuminated by gentle fun so that his classes were never irksome to the students. His kindliness was felt by every student and by everyone else with whom he came in contact, professionally and socially.

A Boston market letter, dated January 9, says: "Alaska gold has offered a very attractive market for traders. It has been tipped for $20, and evrybody has the tip. That being the case, it would seem as though somewhere between $14 and $15 would be a safe place to get off." So you see that even Boston brokers, wise to the business, consider this "security" as nothing more than a football for "traders."

UTAH METAL PRODUCTION FOR THE YEAR 1912

The ore production of Utah in 1912 aggregated close to 7,500,000 tons, valued at about $44,000,000 for its gold, silver, copper, lead, and zinc content, or an increase of 19 per cent, according to preliminary figures by V. C. Heikes, of the United States Geological Survey. The strike of miners at Bingham, lasting forty days, during which nearly all the mines there were closed or operating with decreased forces, caused a decrease of about 500,000 tons in the total ore production. The smelters, however, were not seriously affected, as they operated for a time on the stock reserves and at nearly full capacity the entire year. Owing to the higher price paid for the metals, considerable old mine dump material on various properties, the accumulation of many years' operations, was almost entirely disposed of to the smelters and likewise large dumps of old slags were shipped for re-treatment without sorting. The Bingham camp was credited with an ore output of slightly over 6,000,000 tons in 1912. The Utah Copper property alone yielded approximately 5,520,000 tons, which was an increase of about 15 per cent over the 1911 production. From mines in the Tintic district an increase of 14 per cent in the ore production gave a total output of about 400,000 tons, which was mined from the Centennial-Eureka, Iron Blossom, and thirty other mines. The tonnage includes much low-grade dump material and about 8,000 tons of zinc carbonate and silicate ores averaging about 34 per cent of zinc from ten mines, which will likely continue to ship during the year 1913. Although it was previously known that zinc ore existed in the Tintic mines, it was a surprise to many operators to find such extensive bodies of the ore in the old lead-ore stopes. At Park City the ore output was about the same as in 1911 and aggregated 296,000 tons, of which 42,589 tons were shipped direct to the smelter and the remainder milled, producing about 43,000 tons of lead and zinc concentrate.

The total gold output was about $4,300,000, a decrease of eight per cent from the 1911 production, due principally to the greatly diminished output of the Mercur mines and to the smaller shipments of siliceous ores produced from mines in the Tintic district, where plans are under way for a large cyanide plant to treat the ores of several of the properties.

Silver contained in ores produced in 1912 aggregated about 13,000,000 ounces, this production being about 4½ per cent greater than that of 1911. The increase was probably due to increased shipments of lead ores mined in the Tintic district and from lead concentrates produced in the Park City region.

The copper production of 1912, amounting to nearly 150,000,000 pounds, was an increase of about two per cent over the output of 1911. The increase is credited chiefly to the Bingham district.

The lead output, aggregating about 140,000,000 pounds in 1912, was 2½ per cent greater than the output of 1911. The increase is partly accounted for by the fact that more lead ore was shipped from Tintic and more lead concentrates from Par City than in the previous year.

The production of zinc, figured as spelter, amounted to about 15,500,000 pounds and is about thirteen per cent less than the figures reported in 1911. This decrease is due largely to a falling off in shipments of blende concentrates from Par City. The new producers of zinc ore in the Tintic district were the May Day, Uncle Sam, Godiva, Gemini, Lower Mammoth, Yankee, Ridge and Valley, East Tintic Development, and New Bullion.

Dividends amounting to nearly $9,500,000 were paid from Utah mines during 1912.

THIOGEN PROCESS AND SMELTER FUMES

The smelters located in certain agricultural regions of the west, especially in California, have been operated under great handicap during recent years, or have had to suspend operations, owing to the hostile attitude of the agricultural population toward the smelter fumes, says the Mining & Engineering World. The smelters have gone to considerable expense and trouble to control the fumes and have succeeded as far as the solid matter is concerned. The non-condensible gases, of which sulphur dioxide is the chief troublesome constituent, have most persistently resisted efforts for their satisfactory control. A process that promises much has been devised by Prof. S. W. Young of Leland Stanford University. This is the Thiogen process for converting the sulphurous gases into marketable sulphur.

As mentioned in our columns several months ago, this process has been under test at the Penn Chemical Co.'s smelter at Campo Seco, Cal. The results are reported to have been very encouraging. The process is a chemical one, being a reduction of the SO_2 by passing it mixed with an oil spray and heated to about 800° C. over a mixture of plaster of Paris and sawdust (to give porosity) moistened with water containing a small proportion of iron salts. The volatilized reduced sulphur is passed into a condensing chamber where it is collected as yellow sulphur.

Should this process prove all that is hoped of it, it will be only another demonstration of the solution of a difficult problem forced by necessity. The Thiogen process aims not only to control the sulphurous fumes from roasting and smelting furnaces, but to yield a valuable product—sulphur—as well.

FREIBERGERS ORGANIZE

On Friday evening, December 20, at the Hofbrau-Haus, Broadway and Thirtieth street, New York City, a number of old students of the Freiberg Bergakademie sat down to dinner. This meeting was called for the purpose of forming an association in America to be known as the "Old Freibergers in America."

After the dinner a business meeting was held and the following officers were elected: President, R. W. Raymond, Freibergw, 1861; vice-president, Gardner F. Williams, Freiberg, 1868; and secretary-treasurer, C. L. Bryden, Freiberg, 1907.

It was decided to hold two meetings a year, one on March 25, the anniversary of the founding of the Akademie, March 25, 1765, and the other on the 20th of December, this to be the annual meeting.

The following members were present: Dr. R. W. Raymond, 1861; Gardner F. Williams, 1868; P. J. Oettinger, 1867; Stuart M. Buck, 1868; T. Waln Morgan Draper, 1876; Baron Alfred von der Ropp, 1882; Franklin Guiterman, 1877; F. G. Corning, 1879; R. Boice, 1908; Albert Meyer, 1908; R. M. Payne, 1909; Dr. E. E. Lungwitz, 1886; F. H. Sistermans, 1885; Geo. M. M. Godly, 1900; Walter V. Rohlffs, 1903; H. H. Knox, 1886; H. A. Wilkins, 1889; and C. L. Bryden, 1907.

All old Freibergers who have not already done so, are requested to send in their names and addresses to the Secretary, C. L. Bryden, 1015 Myrtle St., Scranton, Pa.

The value of the metal production of the United States in 1912 was $788,925,046, according to the U. S. Geological Survey.

WHO TAUGHT SALT LAKE CITY TO SMOKE?

Graphic Presentation of Data On a Subject of Vital Importance to Salt Lake People.

By J. CECIL ALTER.

That our once bright and clean maiden like city should in her maturer years acquire the coarse and uncomely habit of smoking, and that to an excess verging on dissipation, brings deep regret on all her lovers; and in the evil of this sadness the admirers of this jewel city of the west are sending bitter hatred and complaint against every owner of every smokestack.

These complainants would have old laws enforced and new laws enacted; they would have violators of the Clean City spirit consumed in their own furnaces, as it were, including their smoke, feeling, as they seem to, that the large furnaces of the city are responsible.

And yet, amidst all this clamor, and against all the evidence showing that Miss Salt Lake is an immoderate coal smoker, it has been almost overwhelmingly proven in a careful and extensive investigation that if every fire in Salt Lake City had been extinguished eleven long years ago, and not a pound of any fuel had been burned here since that time, the dirty smokes and fogs that disgrace us would nevertheless have been more than seven times as numerous as in the previous eleven years with all the fires going; and proven also that coal consumption in the furnaces of the business district of Salt Lake City is next in smallness of importance to the actual tobacco that the men smoke on the street!

And however startling this announcement may be, it nevertheless will not be seriously questioned, even by the so-called smoke experts, after they have examined the records showing the length and date and density of the smokes and fogs which are maintained by the U. S. Weather Bureau in this city, in connection with the statistics of population and coal consumption growths. As shown by the accompanying fog-table, compiled from the government records, there was a total of 25 days on which a light or a dense fog or smoke occurred, during the eleven years ending December 31st, 1901; or an average of about 2 per year, and as most of us will well remember, those were wholesome halcyon days indeed for Salt Lake City, when the winds were welcomed only for what they brought and not at all for what they were able to carry away.

During the succeeding eleven years which ended with December, 1912, there was a total of 221 foggy or smoky days, an average of a trifle more than 20 foggy days per year, or just ten times as many as in the first eleven year period. The climate is not changing, for no meteorological element has changed appreciably except the density and length and frequency of the fogs and smokes.

Now the figures of coal consumption in this city as compiled in part by the State Coal Mine Inspector, have followed very closely upon the population values, which in 1910 were about 70 per cent greater than in 1900. From this information it is perfectly just—and no more than just—if smoke from chimneys is being arraigned for causing the fogs, to take the fog figures for the first eleven year period, add to them the percentage of coal consumption increase, and thus arrive at the fog figures for the second eleven year period. This would give a total of only 42 fogs, or just 3½ per year, though as we have seen, the records show that an actual average of 20 foggy days occurred instead of 3½, and that the increase in fogginess began promptly with 1902.

NUMBER OF FOGGY DAYS AT SALT LAKE CITY FOR TWENTY-TWO YEARS
(Including Dense Smoke. About half of these Fogs obscured view entirely beyond 1,000 feet; the remainder obscuring view beyond a half mile.)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
1891	..	..	..	..	..	..	..	..	..	..	..	..	None
1892	4	4	..	..	..	..	..	..	..	..	..	..	8
1893	2	..	..	..	..	..	..	..	..	..	..	..	2
1894	..	..	..	..	..	..	..	..	..	..	..	..	None
1895	..	..	..	..	..	..	..	..	..	..	..	1	1
1896	3	..	..	..	..	..	..	..	..	..	..	..	3
1897	..	..	..	..	..	..	..	..	..	..	..	..	None
1898	..	..	..	..	..	..	..	..	..	..	1	..	1
1899	..	..	..	..	..	..	..	..	..	..	..	2	2
1900	6	..	..	..	..	..	..	..	..	..	..	..	6
1901	..	1	..	..	..	..	..	..	..	..	..	1	2
1902	8	..	..	..	..	..	..	..	..	..	..	..	8
1903	7	6	5	..	..	..	..	..	..	..	1	10	29
1904	3	..	..	..	..	..	..	1	..	1	..	1	6
1905	1	1	2	..	..	..	..	..	..	..	4	14	22
1906	11	15	4	..	..	..	..	..	..	..	7	3	40
1907	11	3	2	..	..	1	..	..	..	..	7	1	25
1908	6	1	2	..	..	..	..	..	..	5	2	3	19
1909	1	6	..	..	..	..	..	..	1	5	4	2	19
1910	5	1	..	..	..	..	..	3	..	..	4	6	19
1911	2	2	1	..	..	..	..	..	..	..	..	4	9
1912	3	2	1	..	..	..	..	..	..	1	2	16	25

FACTORY AND RESIDENCE SMOKE.

Now before we call in the astronomers to explain just what great sidereal or celestial readjustment took place in 1902 that might cause this increase in fogginess and smokiness (which by the way occurs almost exclusively in the winter time) let us get away from the peculiar illusion of the senses and tradition that the large furnaces are so gravely responsible; how often have we all had a large black cloud rolling away from a chimney top pointed out to us with the remark, "There is the root of the smoke evil," and yet, I repeat, these very volumes of furnace smoke from factory, apartment house, skyscraper, department store, and engine are the very least in importance in considering the fog or smoke nuisance in Salt Lake City, and in almost all cities as well, for that matter.

The compilations of the coal companies, which tally perfectly with the shipping statistics of the railways, show that on the average about 80 per cent of the coal used in Salt Lake City is lump coal, and 20 per cent slack and mine-run. The lump coal is used in the household stoves, in the residence section, the slack is used in the furnaces, and the mine run in the railroad engines and yards. A little fine coal goes to the residence district but it is just about offset by the amount of lump coal that is used down-town, so that, from incontrovertible direct evidence, we find the "big belching stack"

to be responsible for but one-fifth of the trouble; and on closer technical examination we find this figure far too great, for, with automatic stokers, and professional firemen feeding the furnace fires, all scientific writers and studious engineers are agreed—there are no dissenters—that the wasted fuel is much greater among the households, where practically all coal is top-fed on a draught that carries the disintegrating but unburnt coal up the flue into the air, than in the down-town furnace.

An engineer writing recently for the new edition of the Encyclopedia Britannica says the down-town furnace, even with modern appliances, uses on the average about twice as much coal as is necessary, and that the consumption in the residences is six times as great as necessary! And from this evidence we deduce, that there is three times as much smoke from a ton of coal burned in the residence as there is from a ton burned in the down-town automatically—or carefully-fed furnace. Therefore, out of every 100 tons of coal used in Salt Lake City, 80 tons of it (in the residence section) is producing 12 times as much smoke as the other 20 tons is producing down-town

The big down-town furnace, with its picturesque smoke-trail is actually entitled to only one-twelfth the abuse that is heaped upon it, when judged by these figures. Yet, before leaving the furnaces to their calumniators, the further fact must be presented that the draught in the large stacks together with the greater heat of the smoke in them, are influences which carry the smoke much higher than the smoke from the residence chimney, and thus it more quickly reaches the much swifter winds at the greater altitudes, and is thus sooner carried away; and several visits to the benches north and east of the city in the early morning before the city fires were built, from where the interesting smoke kaleidoscope could be watched, have shown conclusively that not only does the furnace smoke rise to about twice the height, (estimated at about 1,000 feet, of the mass of the residence smoke), but that its average texture from street to street is much less homogenous, and that, since it is higher it is carried away much more rapidly.

Of course only a swath of smoke from the residences (about three to five hundred feet deep estimated) as wide as the business district, flows across the business district, though the flow is continuous until the wind or the sun dissipates it; and of the actual smoke existing in the business district at any one time after the great sea of residence fires is started, it is estimated that about two parts out of three of the total smoke are from the residence district, and, when considering the length of time residence smoke flows across the business section, as well as the density of this smoke, it is very conservative to estimate the residence smoke to be responsible for nine-tenths of the trouble; and this owing partly to the fact that the prevailing morning winds are from easterly or southeasterly directions, carrying great quantities of residence smoke across the business district.

PREVAILING WIND DIRECTION BY HOURS, SALT LAKE CITY, UTAH.

(For Hours Ending At):

1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12m	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12m	pr
JANUARY.																								
SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	S	NW	NW	NW	NW	NW	NW	SE	SE	SE	SE	SE	SE	SE
FEBRUARY.																								
SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	S	NW	NW	NW	NW	NW	NW	NW	NW	SE	SE	SE	SE	SE	SE
MARCH.																								
SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	S	NW	NW	NW	NW	NW	NW	NW	NW	SE	SE	SE	SE	SE	SE
APRIL.																								
SE	SE	SE	SE	SE	SE	SE	SE	SE	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NE	SE	SE	SE	NW
MAY.																								
SE	SE	SE	SE	SE	SE	SE	SE	SE	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NE	NE	SE	SE	NW
JUNE.																								
SE	SE	SE	SE	SE	SE	SE	SE	SE	S	NW	NW	NW	NW	NW	NW	NW	NW	NW	NE	NE	NE	NE	SE	SE
JULY.																								
SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	NW	NW	NW	NW	NW	NW	NW	NW	NE	NE	NE	NE	SE	SE
AUGUST.																								
SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	S	S	NW	NW	NW	NW	NW	NW	NW	NE	NE	NE	SE	SE	SE
SEPTEMBER.																								
SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	NW	NW	NW	NW	NW	NW	NW	NW	NE	NE	NE	SE	SE	SE
CCTOBER.																								
SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	NW	NW	NW	NW	NW	NW	NW	NW	NW	NE	SE	SE	SE	SE	SE
NOVEMBER.																								
SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	NW	NW	NW	NW	NW	NW	NW	NW	SE	SE	SE	SE	SE	SE
DECEMBER.																								
SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	NW	NW	NW	NW	NW	NW	SE	SE	SE	SE	SE	SE	SE

SOURCES OF REAL TROUBLE.

But the mere smoke itself is actually not a very serious matter, but rather is it the resultant condition, namely, the "city fog" (a relatively dry fog) caused directly by the smoke. An official investigation in London two years ago showed that 20 per cent of the London fogs were directly caused by city smoke, and that the duration and the density of all fogs were greatly increased; yet the greater part of fog, or the obscuration, was atmospheric moisture built up on the smoke particles. The smoke particles when thrown into the air lose their heat into space and become much cooler than the surrounding air in which they are moving, and a tiny globule of moisture—an actual fog unit—is condensed on the smoke particle or attached to it, thus making the foundation for the very worst kind of fogs.

When the smoke particles are not cooled by radiating their heat sufficiently to condense the moisture upon them from the adjacent air, the fog particles cannot be produced, and such is the condition on the warm mornings in winter, nearly all of which are devoid of fogs; the cold mornings, especially when there is snow on the ground and the relative humidity is high, nearly always produce these smoke-built fogs. For this reason the same amount of smoke in summer is less obnoxious than in winter.

It is interesting to note what a quantity of solid matter, namely, carbon, sulphurous, mineral matter, etc., may be held in suspension by a good robust smoke-made fog, much of which is deposited on all surfaces in contact with the murk. Deposits have been measured as great as 22 pounds per acre; some of this we breathe, some we eat, some gets into our complexion, some into our clothing, and some into our household tapestries and furnishings. Ordinarily about 40 per

cent of the solid matter in the air is carbon; 35 to 40 per cent mineral matter; 10 per cent hydro-carbon, and small amounts of sulphuric acid and a half dozen other substances.

All of this dust would in a few hours float away to be heard of no more were it not for the formation of these dust-built and dust-entangling city fogs; and once a little fog is started the rest of the structure is rapid and continues until arrested by either the bright sun or a stiff wind. The condensing moisture not only increases the density of the fog but prolongs it a great deal, so that the moisture element alone is doubtless responsible for a very large per cent of the actual obscuration and filth distribution

And right here we arrive at a most interesting fact; that there is a chemical element in the smoke, namely, sulphur, in various forms, which is one of the most hygroscopic substances known, and which draws every vestige of moisture to itself that it gets into contact with.

We have observed how foggy conditions are greatly intensified by the moisture condensing on the smoke particles, and this despite the fact that there is no special affinity between the smoke particle and the moisture particle; yet in the sulphur combinations emitted in all coal smoke, we have an element that instantly appropriates, chemically, every atom of moisture it comes in contact with, whether in vaporous or solid form Sulphuric acid, a liquid in bulk at moderate temperatures, draws the water to itself; and sulphur dioxide, which is a gas, is drawn by the moisture particles (usually fog, or incipient cloud units) with equal energy, so that in either case, the moisture-collecting, polluting, combination is formed, and the fog units manufactured and enlarged with great rapidity. It is often claimed by investigating physicists that the actual sulphuric acid is formed by the sulphur dioxide and trioxide appropraiting the additonal water and oxygen molecules, necessary, from the mere humidity, or the invisible gaseous water vapor in the air, thus creating the fog unit independent of those condensed on the smoke or dust particles.

A scientific writer, previously mentioned, writing for the new smoke article in the latest edition of the Encyclopedia Britannica, says of this phenomenon, "The combustion of coal is certainly responsible for their (London fogs) existence, but it is the sulphur of the coal (oxidized ultimately to sulphuric acid) and not the carbon, that is the active agent; and so long as coal is burnt at all, this manufacture of sulphuric acid and of fogs must continue. * * * The evil effects of town air on plant life and human lungs, often attributed to preventable smoke are due to this non-preventable sulphuric acid," going on to say that smoke consumers only burn the visible carbons, and that the sulphurous matter cannot be consumed or rendered harmless.

The sulphur content of Utah coal varies from 0.3 per cent to 1.0 per cent and the average of all coal used in Salt Lake City as shown by the records of the various fuel producers and the State Coal Mine Inspector is 0.70 per cent (seven-tenths) sulphur, all of which gets into the air through the chimneys to assist in collecting and accumulating the moisture by absorption from the air and thus intensifying the fogginess. There seems to be no escape from this conclusion: that sulphuric acid, sulphurous acid, sulphur dioxide, sulphur trioxide, etc., assist in condensing, or drawing the moisture from the air, especially when started by a dust-made cloud or fog unit, and the amount of moisture on winter mornings in Salt Lake City averages about 75 per cent relative humidity, which, surprising as this may seem, is a value only about 10 per cent below the humidity values in the Mississipi valley.

In one of the newer and more complete chemistry text books presented recently before the purchasers of the city's new school books, the interesting fact is stated, "On account of the energetic way in which it combines with water, concentrated sulphuric acid is used for drying gases"; thus showing its possibility as a drying agent for the atmosphere.

AVERAGE HOURLY WIND VELOCITY, MILES PER HOUR, SALT LAKE CITY, UTAH.
(Values Corrected to Homegenous Elevation of 190 feet above Street.)
(For the Hours Ending At)

1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12n	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12M
JANUARY.																							
5	5	6	6	6	6	6	6	6	6	7	8	9	9	9	9	8	6	6	5	6	6	6	6
FEBRUARY.																							
6	6	6	6	6	6	6	6	6	6	8	9	10	11	11	11	10	8	7	6	66	6	6	6
MARCH.																							
7	7	7	7	6	6	6	7	7	9	11	12	13	14	14	14	13	11	9	8	7	7	7	7
APRIL.																							
7	7	6	6	6	6	6	6	8	10	12	14	15	15	16	15	14	12	10	8	8	7	7	7
MAY.																							
6	6	6	6	6	6	7	8	8	10	12	13	14	14	14	14	13	12	10	8	8	7	7	7
JUNE.																							
7	6	6	6	6	6	5	5	7	9	11	12	13	14	14	14	13	11	10	8	9	8	7	7
JULY.																							
7	6	6	6	6	6	5	5	6	7	9	10	11	12	13	13	12	11	10	9	9	8	7	7
AUGUST.																							
7	6	6	6	6	6	6	5	5	6	9	10	12	12	12	12	12	11	9	8	8	8	7	7
SEPTEMBER.																							
6	6	6	6	6	6	6	6	6	7	10	11	13	13	14	14	13	10	8	8	7	7	6	6
OCTOBER.																							
6	6	6	6	6	6	6	5	5	6	8	10	12	12	13	12	11	8	6	6	6	6	6	6
NOVEMBER.																							
6	6	6	6	6	6	6	6	6	6	7	8	10	11	11	10	9	6	5	6	6	6	6	6
DECEMBER.																							
5	5	5	5	6	5	5	5	5	6	6	7	8	9	9	8	7	6	5	5	5	5	5	5

SMELTERS ARE GREATEST OFFENDERS.

And at last we reach the inevitable conclusion, the cruel fact we would avoid if we could, that the sulphur from the valley smelter stacks is responsible directly and solely for the production of 180 foggy days in Salt Lake City during the past eleven years in addition to the 42 foggy days we might have reasonably expected as previously indicated.

The ore handled in the valley ranges from no sulphur to as much as 45 per cent sulphur, if we may take the figures from court records, mine assayers and others more or less familiar with the facts, though a recent court decree requires that an average day's smelting

must not run above 10 per cent sulphur content. To maintain this average, low-grade sulphur ore is fluxed with ore running high in sulphur.

Assuming that the average can be kept as low as 10 per cent (which is not binding by the court on the Murray smelter), with an average day's business at each smelter, Murray and Midvale, of 1100 tons (the court permits 1,500 tons daily at Midvale) there is thrown into the air of the Salt Lake valley 220 tons of sulphur in some or all of its hygroscopic forms every day, or 80,300 tons a year.

Now there were 378,000 tons of coal used in Salt Lake City last year, averaging 0.7 per cent sulphur, or 2,646 tons of sulphur, which is just 3 1-3 per cent as much sulphur as was produced by the smelters!

Careful observations made at practically all hours of the day from Ensign Peak, Red Butte at For Douglas, and the foothills on both sides of the valley, as far south as the smelters, and at the Jordan Narrows, have shown that the smelter smoke is blown against every foot of mountain surface on all sides of the basin-like Salt Lake valley practically every day, and a thorough research into the wind records of he U. S. Weather Bureau show that usually there are no more than three days a month when the smelter smoke is not mixed over all parts of the valley daily as thoroughly as one could mix it in a bowl.

And since the greatest number of hours of wind is from southerly directions, the smelter smoke is almost continually lodged against this slope on which Salt Lake City is built, and therefore Salt Lake City suffers far more from smelter smoke than Murray or Midvale themselves, or any other community in the valley, the smelter fumes often accumulating in our end of the valley so dense as to obstruct the view entirely beyond a half mile.

The smelter smoke appears to offer more resistance than ordinary smoke and thus it hangs together better, so that nothing less than a fifteen-mile per hour wind can dislodge it from the valley completely and give us perfectly clear air, and this strong wind must continue three or four hours from a southerly direction, though a thirty-minute wind at that rate from the northwest will clarify our skies.

The smelter haze is ever present and ever visible in the valley and no matter how thin or attenuated, it is readily recognized by its color; and when blown in accumulations in various parts of the valley, it reassumes the distinctive whitish color it had when leaving the smelter.

The court restraining order, modified by Judge Marshall, requires the Midvale smelter to neutralize its sulphuric acid "by zinc oxide or other effective agent, so that no sulphuric acid shall exist in a free state in said gases." Now since sulphuric acid, chemically, is a molecule of sulphur trioxide SO_3, plus one molecule of water H_2O, equalling He_2SO_4, it is not quite clear just how any true sulphuric acid could exist as such, in stable compound, in any furnace, flue, or chimney, because the water molecule would be vaporized and separated from the sulphur in the intense heat, leaving only the trioxide, or most probably only the dioxide of sulphur. Of course no sulphuric acid goes up, but reversing the old adage, sulphuric acid does come down, for owing to the great affinity of all sulphurs for the water molecule, most of them are oxidized ultimately to sulphuric acid.

NO RELIEF IN COURT ORDER.

The court requires that no sulphuric acid remain "in a free state," (it must be neutralized, or have its teeth pulled, so to speak), so it cannot devour the screening bags in the bag houses, but it certainly is not required that the sulphur be annihiliated, nor is annihilation possible; the neutralization only changes its form chemically, and that only temporarily, it seems, and since all the forms of sulphur are hygroscopic, the moisture-grasping, fog-forming propensity is apparently not mitigated by anything that has been, or can be done, according to good authority. It is therefore possible that the court order is obeyed and that we get the sulphuric acid about the same as before, though our present concern is with sulphur in any form.

The order requires the operation of the bag-house to screen out all solid particles and of course the sulphuric acid would absolutely have to be neutralized, regardless of the court order, to prevent the bags from being literally devoured by the sulphuric acid; for the commercial value of sulphuric acid is largely due to its energy in attacking and decomposing almost everything with which it comes in contact.

The bag-house in good action gets most of the flue dust, and some of the so-called fume particles, but none of the gas, therefore the chimney discharge is mostly the sulphur dioxide, the unneutralized trioxide, and much fine dust (which is just as tangible in fog-making as any other fine dust), and the fuel gases including its hygroscopic sulphurous matter.

Most of the damage heretofore observed from the smelters was the injury to plants and animals caused by the dust and fume particles, but it is the gases and acids that are clogging the valley with fog and "smoke." The flue dust, which is not collected in a bag-house at Murray, is also very hygroscopic and absorbs moisture with great rapidity from the air, thus lending its assistance in the fog formation, in even a more effective manner than do the non-hygroscopic smoke particles that come from our furnace fires. The amount of flue dust, fume dust, and other dusts that goes up the smelter chimneys is enormous beyond ordinary comprehension; while 378,000 tons of coal were consumed in Salt Lake City last year, there were about 850,000 tons of ore, coal, lime, coke and other ingredients that are used in the smelter furnace charge, consumed during the same period, or 2¼ times as much solid matter as the coal in Salt Lake City amounted to. And the dust particles from this, cooling and attaching to themselves the moisture particles because of the mere condensation, this dust alone adds immeasurably to the atmospheric dust that assists the sulphur in the fog formation.

An estimate of the average amount of smelter smoke in the valley places it at 10 per cent or 15 per cent obscuration at 1,000 feet, ranging from none on days of long, steady, hard winds to 25 per cent or 35 per cent, or even 80 per cent in limited localities, or swaths, on quiet days, especially over Salt Lake City, where the "haze" is trapped in the curve of the hills. This value would be near to zero with our wind velocities if it were not for the fact that the Salt Lake valley rigidly confines the fumes. Small quantities of the fumes get over the mountains, and as has been indicated a wind of the proper strength and direction occurs only a few times a month.

At Great Falls, Montana, the world famous smelter stack rises higher than any other scenery for a long-wind-distance, yet with us in the Salt Lake valley the smoke never gets away with less than a fifteen-mile wind, and one that is maintained for some time, which is a very unusual occurrence.

The Salt Lake valley, because of its configuration, is probably the most logical place in the west for a beautiful city and a prosperous farming community; yet it is probably the most inappropriate place in all the world for an ore smelter, so far as the dust and fumes and gases are concerned.

WIND DIRECTION AND VELOCITY.
(December 11, 1912.)
An average day with fog, Salt Lake City.

1am	2am	3am	4am	5am	6am	7am	8am	9am	10am	11am	Noon	(Hrs Ending
SE	SE	S	SE	SE	SE	N	SE	SE	S	W	SW	(Direction)
2	4	5	5	5	3	1	5	6	3	3	3	(Mi. of wind)

Lt. fog 6a to 7:30; Dense, 7:30 to 8:30; Lt. 8:30 to 11 a. m.

And in closing, remembering that southerly winds blow over Salt Lake City at an average rate of six or seven miles per hour from 9:00 or 10:00 p. m. to 9:00 or 10:00 a. m. every day; and that our wretched reputation for smoke and fog dates abruptly with the year 1902, the further fact must be here recorded, that the Murray smelter activities date from the summer of 1902, the Midvale smelter began operations October 1st, 1902, and the Highland Boy smelter was in operation from May, 1898, to January, 1908.

It most certainly appears from direct and circumstantial evidence that it was the smelters that taught the young lady to "smoke."

EXTRACTING GOLD FROM GRAVEL DEPOSITS (III.)

By AL. H. MARTIN.

The elevator method of gravel mining dates back to early hydraulic-mining days in California. The warfare carried on by hostile interests against the hydraulic operator, largely because of deposition of tailings in beds of navigable streams, forced managers to provide for the stacking of gravel in such a way that its presence would not injure the suspicious farmer. The first elevators were inclined platforms, constructed of timber. The gravel was driven up the incline by streams of water and dropped over the end. In some instances steel elevators were later employed, the metal more readily resisting the abrasion of the boulders and sharp gravel. The method proved highly desirable when the dumpage ground was limited, and also facilitated working of ground where direct hydraulic practice was attended with some drawbacks. Within recent years it has become particularly popular in California, Oregon and other placer fields, where maximum results with a minimum of time, labor and expense, are requisite. The method has been given particular attention in Siskiyou county, California, and Josephine and one or two other counties in Oregon, and has attained its highest development in these districts.

CLASS OF ELEVATORS USED.

The elevator, as now generally used, is in the form of an inclined trough, solidly constructed of timbers, braced at points where the strain is greatest, and protected with steel plates and bands to resist the abrasion of the material. The main platform is usually eight feet wide and eighty to 100 feet in length, with the lower section composed of two layers of 1¼-inch boards. The upper portion, composing from one-third to one-half of the total length, is built of one layer of timbers. The sides vary from twelve feet wide at point of ingress to six feet at top. Each of the two sides is formed of two banks of boards, the thickness depending on the desire of the builder, although care must be exercised to form the walls sufficiently strong to resist the outward pressure of the water and gravel as it moves upward. From the elevator to the bed of gravel extends the bridge, or approach. This is generally ten feet long. The bridge and first twenty feet of the main platform are solidly constructed of heavy timber and strongly braced, as on this portion comes much of the weight and strain in operation. Steel plates one-eighth inch thick are used to protect the bridge and upper portion of incline, as the bare timber wears out rapidly under the rush and wear of the driven gravel.

At first operators were inclined to use heavy timber alone, but practice convinced the more progressive engineers that the initial cost attending the use of steel plates was amply justified, and that in the end the expense was less than when timber alone was used. In the latter instance, the time lost in replacing worn-out lumber, together with cost of labor and material, are militating factors, even in regions where excellent timber is cheap and easily obtainable. The grizzly-bars are placed at the upper portion of the elevator. These have dimensions of approximately three by six inches, protected with steel bands three inches wide and three-eighth-inch thick. The sluice boxes are placed in the elevator beneath the grizzly-bars. The riffles are situated transversely, with occasional longitudinal riffles employed to more thoroughly wash the gravel and increase the gold-saving efficiency. The riffles are formed of two by four-inch timber, covered with quarter-inch steel. The whole device is carefully placed on a solid foundation, in order to lessen vibration and avoid unnecessary strain on the somewhat unwieldly platform.

OPERATION OF "GIANTS."

Two or more giants are employed in operation. The first cuts down the gravel bank as in ordinary hydraulic mining, while the second is situated about eighty feet in front of the elevator bridge. The material washed down by the first monitor is driven behind and alongside the second, and is in turn carried upon the bridge and elevator by the auxiliary giant. The force of the hydraulic jet easily carries the mass of gravel and water up the incline and over the grizzly-bars. The fine material, containing the gold, drops through the bars into the sluice boxes in the body of elevator, while the coarse tailings are carried over the platform and dropped onto the tailings dump. Boulders up to five feet in diameter are easily carried over the incline in this manner, and by blasting the large rocks, the operator easily cleans the entire bedrock and secures a maximum gold recovery.

As the tailings pile grows in dimensions and approaches the elevator too closely, stringers, covered with a double set of boards are extended from the platform over the dump and the material ran further out. In this way an immense quantity of debris can be stacked on a limited area. When an abundance of water is available, and the property is sufficiently extensive to justify the added equipment, a third giant is often employed to drive the tailings from the dump to a barren waste ground. In this practice the third monitor drives the tailings to the dump pile as the material is dropped over the rear of the incline. While this may be advantageously employed in favorable cases, the third giant is rarely employed by small operators, as the use of timber platforms extending from the main elevator facilitates the stacking of gravel at low costs and on a satisfactory basis.

In practice it has been demonstrated that two No. 3 giants, using approximately 1200 inches of water under a 450-foot pressure, can easily handle 1200 cubic yards of gravel per day under ordinary conditions. The elevator method is successfully employed in mining gravel ranging in depth from twenty to twenty-five feet, with deposits containing numerous boulders and much difficult gravel. The mining of the ground is identical with the methods followed in hydraulicing, hence a description here is superfluous. On a property of fair extent, two or three elevators are easily operated, provided a sufficient water supply is available.

One of the objections against the elevator is the time lost in moving the machine, but under usual conditions, an elevator may be easily moved from point to point by four men and a mule, if capstan bars and other equipment are provided. As in ordinary hydraulic mining a good water supply is absolutely requisite, and the manager is necessarily forced to provide for this, before commencing the installation of equipment.

The use of the elevator has recently

spread to Alaska, South America, and other fields, and in most instances has filled a long-felt demand. The facility with which the tailings are stacked, and the compact character of the device, compared with the ordinary sluice-ways in hydraulicing, forms paramount points in its favor. The fact that elevator mining can be conducted in districts where the water resources are comparatively restricted forms another distinct factor in favor of its use. The elevator method was inspired by the attack of the anti-hydraulic forces, but its greatest development has been in districts where hostile legislation has made scant progress.

METHODS OF STACKING DEBRIS.

An effective method of stacking debris has been recently developed in some of the Alaskan and British Columbian fields, and is of considerable interest to the American placer miner, when disposition of tailings forms an important problem as not unusually prevails. In this system two or three giants are placed at the lower section of the sluiceways, with their streams trained to meet the tailings at right angles as they issue from the boxes. The terrific driving force of the hydraulic jets meets the gravel with full volume and drives the heavy material to the side. Gradually a pile of tailings is built up the heap strikingly resembling the rock piles built by the stacking belt of the modern gold dredge. As the dump gathers height, the monitors are elevated gradually and a wall of gravel erected. The giants are raised or depressed as occasion warrants, until the piles attain a height of fifteen to twenty feet. The ground in front of the sluices is constantly kept clear of debris, and a restricted dumping space used most advantageously. The escaping water carries considerable fine material into the streams, but in Alaska and portions of British Columbia this is permissible, and no attempt is made to prevent the deposition of the fines in the creeks. The method described might be employed in anti-hydraulic sections, provided the water was led into restraining ponds. The great drawback against this method of stacking tailings is the large valume of water required, but in favorable districts it has proven highly effective, and is particularly popular in instances where the dumping ground is limited. The water naturally has a low duty, and considerable hydraulic equipment is required for its best employment.

The elevator method has been comprehensively tested in numerous fields and has proven its merit beyond question. It is particularly favored in districts where the water flow is comparatively limited, and is an excellent practice in disposing of tailings. Many engineers assert that it is the only machine to use in refractory ground, where water resources are restricted, and dredging is unsatisfactory. The water is conserved and a good quantity of gravel easily and fairly economically treated. In California and Oregon, costs are stated to average six to seven cents per cubic yard, with the material usually heavy and somewhat difficult to mine. When it is considered that the elevator method has been most extensively employed in a strictly hydraulic mining field, it is evident the practice must have merit. While eight to nine days are required to change and set up a machine, including the removal of giants and pipelines, the time and expense thus consumed is not infrequently balanced by the ability of the elevator to work with a small quantity of water, when a strictly hydraulic installation would be practically out of action.

THE PUMP DREDGE.

The pump-dredge claims sunny Australia as its birthplace. And to this nation and New Zealand its growth has been principally confined. Its inception and evolution was due largely to climatic coditions. Most of Australia is deficient in rainfall, and from the first the placer miners were confronted with the problem of winning the auriferous values with a minimum water supply. The dredger was early evolved in this country, but in numerous sections conditions were such that the cost of installation did not justify the building of a dredge. As necessity breeds progress, it took only a few years to develop a method for the winning of the gold from the comparatively dry placers. In Australia the pump-dredge is employed in the mining of both gold and tin, and its efficiency is demonstrated by the employment of thirty-seven machines in the province of New South Wales in 1911, while a large number were also employed in Victoria and other fields. In New South Wales ground averaging eight to nine cents per cubic yard was profitably mined, while in Victoria the material treated averaged around 12 cents.

From best figures obtainable, it appears that operating costs ranged from seven to eleven cents, depending on the natural conditions involved. The pump dredges of New South Wales treated 3,794,211 cubic yards of material in 1911, with an approximate gold and tin extraction of $830,000. The greatest field in Australia for the pump-dredge is where water is not noted for its plentitude, and where the placers are limited in extent, and the gravel somewhat difficult to dredge.

CONSTRUCTION OF PLANTS.

The pump dredge, or pump hydraulic sluicing plant, as it is sometimes designated, consists of pumps and sluices. The dredge is built on a pontoon and operates from dry land, with a flotation pond provided when possible to facilitate the moving of the equipment when conditions demand a change of operations. Should water for this purpose be deficient other means may be readily impressed to alter the position of the machine. The pontoon generally has dimensions of 40 by 50 feet, with a four-foot depth. In the case of smallest types, the platform has an average size of 30 by 40 feet. The pontoon is solidly constructed of timber, and is really a movable platform to carry the pumps. Two centrifugal pumps are mounted on the platform and wash down the gravel and elevate to the sluices. When sufficient water is available the gravel is mined by a hydraulic giant, but when this is not feasible a fourteen-inch pump generally delivers water to a four-inch monitor for gravel washing. By this method a stream of water is delivered under sufficient force to the giant to break down gravel and sluice the material to a sump situated directly in front of the dredge. The second machine, a ten to twelve-inch centrifugal gravel pump, gathers the material from the sump and elevates it to the sluice boxes. To resist the abrasion of sand and gravel, this pump is steel lined. When the gravel is very coarse, or large boulders abound, the material is screened before passing to the gravel pump. While the necessity of screening presents some objection, the cost is slight, and operations attended with little annoyance. Occasionally a particularly high lift is required, and when this occurs, the pumps are operated in series. Some of the Australian companies elevate gravel over a hundred feet by this method, and the height to which the material can be thus carried is practically unlimited. A seperate engine or motor is generally employed to drive each pump, but if desired both pumps may be operated from the same source. In the more recent designs, however, independent engines are used, resulting in the maximum application of power and ability to operate one pump should an accident to one of the engines or motors place the other out of action. By keeping an auxiliary motor or pump in reserve loss of time through accident to the active machinery is avoided. In Australian practice steam is largely employed as the motive force, but whenever possible electricity is preferred. Either mode of power may be employed, and steam can, of course, be often employed in districts where electricity is

unavailable. The approximate indicated horsepower required to operate an average size pump-dredge ranges from 120 to 260.

LOCATION OF SLUICES.

The sluices are situated either above the dredge, or at a convenient point on the bank, and are provided with a set of boxes for the conveyance of the tailings to the settling pond. In many of the Australian districts rigid laws against deposition of tailings in navigable streams prevail, and the pump-dredge operator is naturally forced to respect the eixsting regulations. The tailings are easily distributed to restraining ponds and all escape of fine material effectively prevented. The pump elevating the material from the sump gathers the water with the gravel and discharges into the sluices, from which all excess water is readily returned to the pump supplying the mining giant. In this way the same water is used many times, and its duty largely augmented. The quantity of water required is naturally regulated by the structure of the ground and amount of gravel handled, but it is estimated that 2500 gallons are required to each cubic yard of material elevated. As most of the water is used over and over, the initial supply need not be large, as compared with other methods of placer mining. Neither is it necessary that the pressure be particularly strong, as the pump supplying the giant increases the power of the flow sufficiently to enable the giant to effectively perform the services demanded of it. As work progresses the dredge is floated from point to point, or moved across the dry land with the aid of men and horses, and attendant equipment. A flotation pond is always provided if conditions permit, and by this means the moving of the dredge from one point of attack to a new location is accomplished with the same ease that the bucket-elevator dredge is stepped ahead.

The reports of the Victorian Government records the successful dredging of gravel ranging in depth from thirteen to over fifty-three feet, with many of the deposits of a refractory character. When the deposit is situated in a ravine or canyon, the material may be easily elevated to the sluices situated on higher land by employing additional pumps. Accordingly, the pump-dredge is extensively employed in the mining of deposits that could hardly be otherwise worked. While the costs attending the construction of a pump-dredge varies with local conditions, the average building epense ranges from $15,000 to $30,000, depending on dimensions of the installation. Taking all factors in consideration, and applying a general rule to calculations, the Australian engineer reckons on $20,000 to $28,000 for a dredge of ordinary power and size. Compared with the high cost of the bucket-elevator dredge, the expense attending construction of a pump-dredge is insignificent.

ORIGIN OF PUMP-DREDGE.

The idea of the pump-dredge properly originated from the employment of gravel pumps on the old-style double-lift bucket-elevator dredges. In this practice the gravel was dumped by the dredge buckets into a watertight compartment on the boat. Centrifugal pumps then gathered up the material and elevated to the sluices extending behind the dredge. The Australian pump-dredge is the application of the hydraulic principle for the mining of the ground, and of pumps for the raising of the material to the sluices. In other words, the monitor and pumps perform the work of the bucket line and stacking conveyor on the elevator dredge. The elevator dredge performs the work more rapidly and economically, but the pump-dredge operates in districts where the employment of the modern gold elevator boat is practically precluded. The elevator dredge is a costly affair, and the ground must be sufficiently extensive to justify its installation. No dredge mining engineer would think of installing a dredge in a district where the area was so limited that the eventual result would mean loss to the company. The place of such boats are in large fields where a fairly lengthy period of operation is assured. And it is in the mining of the small deposits that the pump-dredge has proven particularly efficient. The pumps clean the bedrock more effectively than any other method, and practically every speck of gold is recovered from the channel in this way. Even the most uneven bedrock is forced to yield up its finest particles of gold.

The great field for the pump-dredge is where the district contains small deposits, particularly when scarcity of water and rough bedrock militates against hydraulic mining or other methods of placer activity. In usual hydraulic practice a constantly fresh supply of water under strong pressure is requisite, and a convenient dumping ground, lower than the worked deposit, is preferable. In dump-dredging the same water is used many times and the pumps readily elevate the product to dumping ponds located far above the placers. In this way a small supply of water may be effectively applied, and the tailings distributed to best advantage in a restricted dumpage area.

Another point in which the pump-dredge excels is its ability to operate in districts where hostile legislation prohibits hydraulic mining under ordinary methods. The tailings are easily run to the settling ponds and the withdrawal of excess water from the restraining dams prevents the escape of the fine material to the streams draining the territory. This factor in itself is worthy of emphatic attention. In California and other fields where anti-hydraulic laws have closed placer properties of unquestioned merit, the disposition of the tailings forms the paramount factor. Efforts have been made to operate by constructing costly restraining barriers to hold the debris in leash, but rarely without completely satisfactory results. In Australia the pump-dredge is said to have solved this important problem most effectively. As most of the water is returned to the pumps from the tailings ponds, the fine material settles and is less easily dislodged, even by the fiercest of winter storms.

WHERE PUMP-DREDGE SHINES.

The pump-dredge was never intended to take the place of the bucket-elevator dredge. It can not compare with the latter in point of efficiency, low operating costs, or capacity. It finds its greatest application in districts where conditions are inimical to the elevator dredge, where restricted deposits, unfavorable ground and other circumstances do not warrant the installation of the larger and more costly boats. It has proven particularly efficient where it has been necessary to elevate the gravel to obtain a sluicing grade. It is intended to do for the small, isolated deposit what the bucket machine accomplishes in the district of vast gravel channels and fairly good workable ground. The high operating costs, compared with that of the bucket dredge, necessitates that the deposit contain a fairly high gold content, otherwise an installation could not but result in failure. The engineer must be conversant with extent and structure of the deposit before recommending an installation, whether the machine be a pump-dredge, hydraulic plant or elevator dredge. All pump-dredges have not been successful, but when conditions have been favorable the percentage of failures are reported to have been exceedingly small.

Thus far the pump-dredge has been given scant attention by the American placer miner, although there are numerous districts in the western states where it could undoubtedly be profitably installed and operated.

A comparison of the elevator and pump-dredge methods of placer mining is necessarily dependent on strictly local conditions. There are districts where each method is peculiarly available and advantageous, and the writer is unaware of a single instance in which the two machines have been placed in direct competition under identical circumstances

Both methods facilitate the working of small deposits with a minimum water supply, and tailings are effectively handled in either instance. Screening is unnecessary in elevator mining, but the centrifugal pumps clean the rough bedrock far more effectively than ever the elevator operator dreamed of. It seems that in many districts the two machines might be combined effectively into a complete plant, but in most instances this would probably be unnecessary, as either contrivance performs its work well.

The elevator method is well understood by the American placer operator, but the pump-dredge has been hitherto neglected, although its merit has been conclusively demonstrated by the operators of a foreign region, where natural conditions not infrequently resemble those confronting the miner in many placer fields of America.

In Australia labor forms the most costly item on the expense sheet, often ranging six to eight cents per cubic yard. By operating a number of machines, this cost would naturally be reduced by a strong company, directed by intelligent management. Power costs command consideration, but in many American districts electricity is available at fair rates, and this would probably result in operations at costs below the scale prevalent in most Australian districts. In any event the pump-dredge is entitled to more consideration than has been accorded it by American operators.

Production of Copper in 1912

Statistics and estimates received by the United States Geological Survey from all plants known to produce blister copper from domestic ores and from all Lake mines indicate that the copper output of the United States in 1912 exceeds that of any previous year in the history of the industry. Not only is the total output the largest ever recorded, but six of the large copper-producing states—Arizona, Michigan, Utah, Nevada, New Mexico and Alaska—have each exceeded all former records of production, while Montana and Tennessee have nearly equaled their previous record productions.

SMELTER PRODUCTION.

The figures showing smelter production from domestic ores, which have been collected by B. S. Butler, of the Geological Survey, represent the actual production of most of the companies for eleven months and an estimate of the December output. The November figures for a few companies were not available and these companies furnished estimates for the last two months of the year. According to the statistics and estimates received, the output of blister and Lake copper was 1,249,000,000 pounds in 1912, against 1,097,232,749 pounds in 1911.

At an average price of about 16 cents a pound the 1912 output has a value of nearly $200,000,000, against $137 154,092 for the 1911 output.

REFINED COPPER.

Preliminary statistics showing the output of refined copper are not collected by the Geological Survey. Figures published by the Copper Producers' Association show an output of 1,429,147,150 pounds for the first eleven months of 1912 and indicate that the production of marketable copper by the regular refining plants from all sources, domestic and foreign, will amount to about 1,560,000,000 pounds for 1912, against 1,433,875,026 pounds in 1911.

IMPORTS AND EXPORTS.

According to the Bureau of Statistics imports of pigs, bars, ingots, plates, and old copper for the first eleven months amounted to 276,508,505 pounds, and the copper content of ore, matte, and regulus imported amounted to 94,486,041 pounds. If the imports for December were equal to the average monthly imports for the first eleven months the amount of copper entering the United States for the year was about 404,721,323 pounds, against 334,607,538 pounds for 1911. Considerable of the copper imported as blister had been previously exported as ore.

Estimates based on figures for the first eleven months published by the Bureau of Statistics and also by the Copper Producers' Association indicate that the exports of copper for 1912 will not equal those of 1911 but may exceed 750,000,000 pounds.

Stocks of refined copper held in the United States January 1, 1913, are probably about the same as on January 1, 1912. Foreign stocks show a considerable decrease.

DOMESTIC CONSUMPTION—PRICES.

Statistics published by the Copper Producers' Association show the domestic deliveries for the first eleven months of the year as 761,174,225 pounds and indicate a marked increase in domestic consumption, which will probably reach 825,000,000 pounds for the year and may exceed that amount.

The average quoted price of electrolytic copper for the year showed a marked increase over that for 1911. The average for 1912 was about 16 cents a pound, as compared with 12.5 cents a pound for 1911. The year opened with copper at about 14 cents a pound, but since June the monthly average has not been below 17 cents.

COPPER-PRODUCING STATES.

Arizona—For 1912 Arizona again holds first place among the copper-producing states. The output will show a large increase over the 303,202,000 pounds produced in 1911 and may exceed 350,000,000 pounds. This is not only the largest output ever made by the state but the largest ever made by any state for one year.

The production of copper from the Bisbee district will show a large increase over the 130,200,000 pounds in 1911 and may exceed 145,000,000 pounds for 1912. A new smelting plant was under construction by the Calumet & Arizona Co. during the year.

The output of the Morenci-Metcalf district will show a considerable increase over that of 71,500,000 pounds for 1911 and may reach 80,000,000 pounds for 1912. The building of a new smelting plant by the Arizona Copper Company was in progress during the year.

The Globe-Miami district will show a large increase over the production of 44,600,000 pounds in 1911, this being due to the larger output by the Miami Copper Company. The production for 1912 may reach 55,000,000 pounds. The larger producers were the Old Dominion, United Globe, and Miami companies. During the year the Inspiration Consolidated Copper Company was formed by a merger of the Inspiration Copper Company and the Live Oak Copper Company. Development and blocking out of ore was carried on by this company and plans for a concentrating plant set under way. Development was carried on by other companies.

In the Jerome district the output of the United Verde mine will show little change from the 33,200,000 pounds produced in 1911.

The production of the Mineral Creek or Ray district will show a large increase over 1911, owing to the larger output of the Ray Consolidated Company, the only large producer of the district. The output for the year will be between 30,000,000 and 35,000,000 pounds.

In 1912 the Ray Consolidated Company secured controlling interest in the Ray Central Company and the properties will be worked together. The smelting plant of the American Smelting & Refining Company at Hayden was placed in operation during the year.

Montana—The copper output of Montana will show a large increase over the 271,814,491 pounds produced in 1911, owing to the stimulation to production

given by the increase in the price of copper. The 1912 output may reach 310,000,000 pounds. The Butte district, as in previous years, was the only large producer. Montana ranked second in copper production in 1912.

Important additions to the ore reserves of the Butte district are reported and improvements have been made in the methods of extracting and treating the ores with a view to decreasing the cost of production.

Michigan—The production of copper from Michigan, which ranks third among the copper-producing states, will show an increase of nearly 15,000,000 pounds over the output of 218,185,235 pounds in 1911. The output was made largely by the old producers and the increase was due to the stimulation of higher metal prices. Development of new territory has been active during the year.

Utah—The production of copper in Utah in 1912 will show a considerable increase over the 142,340,215 pounds produced in 1911, the increase being due to the increased output of the Bingham district. As in previous years, the Bingham camp was the main producer, though the Tintic district had a considerable production and the San Francisco and other districts also contributed. The output of the mines at Bingham was stopped for a time in the latter part of the year by labor troubles, thus materially reducing the ore production of the state.

Nevada—The copper production of Nevada in 1912 will show a large increase over the 65,561,015 pounds produced in 1911. The increase is due largely to the beginning of noteworthy production from the Yerington district. The total state output for 1912 will probably reach 80,000,000 pounds. The Ely and Yerington districts were the only large producers. In the Yerington district the smelter of the Mason Valey Mines Company was blown in early in the year and operated thereafter. The output of the district will probably reach nearly 15,000,000 pounds. The Ely district will show a slight increase over the 64,900,000 pounds produced in 1911, though production was interfered with by labor troubles in the latter part of the year.

California—The production of copper in California in 1912 will probably show little change from the 35,835,000 pounds produced in 1911. As in previous years the Shasta county district was the largest producer, but notable contributions were made also by the Foothills district and other districts of the state.

New Mexico—The output of copper from New Mexico in 1912 will show a large increase over that of 1911, owing to the beginning of noteworthy production by the Chino Copper Company, of the Santa Rita district. The total production of the state will reach nearly 30,000,000 pounds, the large part coming from the Santa Rita district.

Alaska—Alaska will show a large increase in the production of copper in 1912 over the 22,314,000 pounds produced in 1911, the total having been estimated as 28,940,000 pounds. The output came largely from the Copper River and Prince William Sound districts, though southeastern Alaska also contributed.

Tennessee—Tennessee will show but little change in copper production in 1912 from the 18,965,000 pounds produced in 1911. The output, as in previous years, came from the Ducktown district.

Colorado—The output of copper from Colorado is largely incidental to the production of other metals and will probably show no great change in 1912 from the 9,791,000 pounds produced in 1911.

Idaho—Idaho will show a considerable increase in copper output in 1912 over the 4,514,116 pounds produced in 1911.

There will be no new large producing mines added during 1913. Several of those that began producing in 1911 and 1912 will, however, turn out larger quantities than in 1912. At the prices for copper prevailing during the latter part of 1912 the industry is highly profitable, and if the output can be marketed and the price maintained the producers will be in a position to make a still further large increase in 1913.

PIKES PEAK NOT THE HIGHEST.

What is the higest mountain in Colorado? "Pikes Peak," nineteen persons out of twenty will answer, and incorrectly. The twenieth may know that the two highest mountains in the state are Mount Massive and Mount Elbert, both in Lake county, in the Leadville district. The altitude of each of these mountains, according to the United States Geological Survey, is 14,402 feet above sea level. The height of Pikes Peak is 14,108 feet. Moreover, there are fifty or sixty other peaks in Colorado approximately as high—over 14,000 feet. The lowest point in Colorado is 3,350 feet above sea level. Of all the states Colorado has the highest average altitude, estimated by the Geological Survey at 6,800 feet.

Although not the highest mountain, Pikes Peak is probably the best-known peak in the United States. There was at one time a Weather Bureau station on its summit, and it now has a substantial railway station at the terminus of the highest railway line in North America. It can also be reached by an excellent wagon road and trail which connect the summit with Colorado Springs.

NO FREE ASSAYS MADE

Attention is called by the United States Geological Survey at Washington to the fact that it does not make analyses or assays of ores or metals for private parties. Many specimens and samples are received by the Survey, accompanied by requests for such treatment, with which it is impossible to comply. The force of chemists employed in the Survey is small, and their time is fully occupied by their regular official duties. The Geological Survey has no facilities at all for making gold and silver assays. The most that can be done is for the Survey geologist to give an off-hand opinion based on a simple examination of the specimen. If an assay is desired, the proper course is to employ a private assayer or to send the specimen to one of the government assay offices, where a regular charge is made for such work. When specimens are sent to the Survey for examination, applicants should be particular to state whether they wish them returned, as otherwise they will be destroyed. Government assay offices are located at Carson, Nev.; Seattle, Wash.; Boise, Idaho; Helena, Mont.; Salt Lake City, Utah, and Charlotte, N. C.

E. & M. JOURNAL'S NEW DRESS

The Engineering and Mining Journal is out in a "new dress"—that is, it has changed the style of its make-up from three to two columns to the page and is using a new and larger-faced type. One of the charming features of the Journal, always, has been its scrupulous attention to "dress" (mechanical appearance) and, while there are most likely compensating features in the latest change, it will take readers some time to convince themselves that the "new suit" can be compared with the old. The face of the body type is not nearly as pretty and it lacks in classy individuality. The longer lines will unquestionably result in better spacing between and division of words, and these are features that will appeal to writers, proof-readers and patrons, as well. But the Journal, in its old dress, was a handsome reflection of the art of printing and the change comes rather as a shock than a refreshing surprise. However, tastes differ materially, and possibly no one else will view the change as we do. The Journal is, without question, the best of its class in the world, and whether it appears in "homespun" or "broadcloth" will make little difference to the thousands who consult its pages with religious regularity.

From Copper To "Gold Mines"

This space is reserved for the picture of A. F. Holden, the other eminent engineer who lent his name and gave his endorsement to the electrifying report on Alaska properties submitted herewith and which will be reproduced from month to month.

NOTED ENGINEERS JOIN BROKERAGE HOUSE IN A REMARKABLY PECULIAR PRESENTATION OF AN ALASKA GOLD MIRAGE.

We have considered the PROBABLE capital requirements for a capacity of 6,000 tons per day, which contemplates a hydro-electric power plant; mine development and equipment, including all the necessary living quarters, both at the Perseverance mine proper and at the mill, and driving the long adit tunnel. We BELIEVE that $4,500,000 will do this owrk.

Our belief is that the substantially INDICATED ore body is about 4,500 feet long by seventy feet wide. The value of the 600,000 tons of ore THAT HAVE BEEN MINED FROM THIS BODY IN THREE DIFFERENT LARGE STOPES INDICATES that a recovery of at least $1.50 per ton can be made. We BELIEVE that there will be 75 cents per ton profit in this grade of ore. The Sheep Creek Tunnel which will be driven on the vein as the main haulage level, will develop this ore body at an average depth of about 2,200 feet on the dip of the vein or about 700 feet deeper than present developments.

The character of this vein is similar in A VERY GENERAL WAY to other large deposits of gold ore in the same vicinity in which the values at a vertical depth of 1,600 feet, or 2,000 feet on the dip of the vein from its apex, are practically the same today as they were on the surface, and have been throughout the development of THE DEPOSITS IN QUESTION. We visited these mines and saw THEIR deep levels, and if there is any inference to be drawn from the continuity of THESE ore bodies, WHICH ARE NOT, HOWEVER ON THE SAME VEIN AS THE PERSEVERANCE, one MIGHT BE TEMPTED to say that there is a PROBABILITY of ore 2500 feet deeper than the so-called Sheep Creek Tunnel which we contemplate driving, BUT, while the PROBABILITY is there of the vein and values extending to great depth, THERE IS NOTHING TODAY TO WARRANT ANYBODY IN STATING THAT IT IS A FACT THAT SUCH WILL BE THE CASE.

There are substantially 50,000,000 tons in the ore body we consider definitely INDICATED. There is a PROBABILITY of another 2,000 feet to the east of the 4,500-foot ore zone previously mentioned which, from surface indications, would seem FAIRLY CERTAIN to contain ore. Beyond this is some 1,800 feet of the vein concerning which we have NO FINAL OPINION one way or the other, AS WE VISITED NO WORKINGS OR OUTCROPS from which we could secure sufficient data to form accurate deductions. While we cannot at this time state that there IS ore here, there were several SMALL MINES worked almost at the extreme east end of the vein on this property, which INDICATES that this 1,800 feet will undoubtedly produce considerable ore and PERHAPS LARGE QUANTITIES. If we do not consider this in the PROBABILITIES, it is certainly well within the POSSIBILITIES.

This letter is based solely on a consideration of $1 50 recoverable value as ore. If one should figure on lower values assuming 75 cents as the total cost of mining and milling, the tonnage now indicated is INDEFINITE, but certainly enormous. We BELIEVE that sound mining business will INDICATE that for the installation now proposed and for an operating period of, say, two years, IT WILL BE WISE TO CONFINE OUR WORK TO THE HIGHER GRADE ORE. There can be, in our opinion, little doubt that at some time in the comparatively near future A VERY MUCH LARGER PLANT than the one now proposed will be installed for the purpose of working a larger tonnage of the normal grade ore we now EXPECT will be developed, or of utilizing the apparently vast quantity of lower grade material.

The INDICATED earnings from the installation now contemplated are approximately $1,500 000 per annum. Considering the TREMENDOUS POSSIBILITIES, and we use the word "tremendous" advisedly, we BELIEVE this mine to be a LEGITIMATE purchase at $15,000,000 and A BARGAIN at $12,000,000, provided that, in both cases, a development,equipment and working fund of $4,500,000 is made available. You must understand and appreciate that we do not consider the 6,000-ton per day development and installation as the ultimate possibility of the mine or anywhere near it. The POSSIBLE tonnages of ore INDICATED in this property APPEAR to be greater than any vein deposit WE know about.

We EXPECT the first unit of the new mill to be in operation on or before January 1st, 1915. We really BELIEVE that, barring accidents the time MAY be made July 1st, 1914.

(Signed, July, 1912.) D. C. JACKLING.
A. F. HOLDEN.

Already the management of this herculean undertaking is preparing to increase the stock and issue bonds under the bold assumption that the 50,000,000 tons of ore now "believed" to exist will be increased to 200,000,000 tons within a short time. This showing, an article in the Evening Telegram of recent date, says, will require making the proposed 6000-ton mill a 20,000-ton affair. Thus, before it is known whether the ore can be treated at any profit—really before it is known whether the ore will average even 25 cents a ton in recoverable value, the company's proposed new financing scheme is being exploited. First they tell you they "believe" $4,500,000 will be ample for all purposes of development and equipment. Then, almost before the ink is dry on that published statement, they begin paving the way for bleeding the public proper. The next stock will be put out at $20 or $25 a share, they promise.

MIAMI COPPER COMPANY'S MINING AND MILLING ENTERPRISE

By JAMES O. CLIFFORD.*

The mines and mill of the Miami Copper Company are at Miami, Gila county, Arizona, about eight miles northwest from Globe. Miami is at the extreme western terminus of the Gila Valley Globe & Northern railway, a branch line of the Southern Pacific railway, connecting with the main line at Bowie, 134 miles southeast of Miami.

The company controls about 1250 acres of land in the Miami district, of which 300 acres are mineral, the remainder being held for mill purposes, and water right. Other mining properties immediately adjoining the Miami Copper company are: Inspiration, Keystone, Live Oak, and South Live Oak, and all of which are opened upon the same orebody. At present the Miami Copper Company is the only producer of the district, though preparations are now under way for the construction of a 7500-ton mill on the Inspiration property.

As outlined in a previous paper (Mines and Methods, December, 1912), the Miami district, geologically, has many features in common with the Ray district, the latter twenty miles southwest. Here, as at Ray, the workable ore of the disseminated copper deposit practically is confined to the altered schist, though intrusive tongues of granite-prophyry in the schist also are ore-bearing.

Generally speaking, the Miami district is an exact counterpart of the Ray district, the rock series of the ore-bearing area consisting principally of a granitic basement overlaid by altered schist, through which diabase has been intruded. Remnants of an extensive dacite flow which formerly covered the schist is apparent, both as capping on the surrounding hills, and as huge boulders (in many instances heavily mineralized) along the faults of the Miami mine. A large mass of conglomerate occurs immediately to the east of the Miami shaft No. 2. Limestones, shales, and quartizites are not present, only to the east and the south of the Miami orebody.

The structural relations of the Miami rock series are practically the same as those at Ray. Reverse faulting occurs at many points throughout the developed area. Also, in many instances, what are really "lines of erosion" are often mistaken for fault planes.

The principal ore deposits at Miami consist of an unusually fine dissemination of chalcocite throughout a mass of altered schist, with accompanying veins of solid glance—the latter generally along lines of greatest fracturing, and adjacent to the porphyry. Chrysocolla occurs in unusual development in the extreme western limit of the district. Pyrite and chalcopyrite occur locally in the upper horizon.

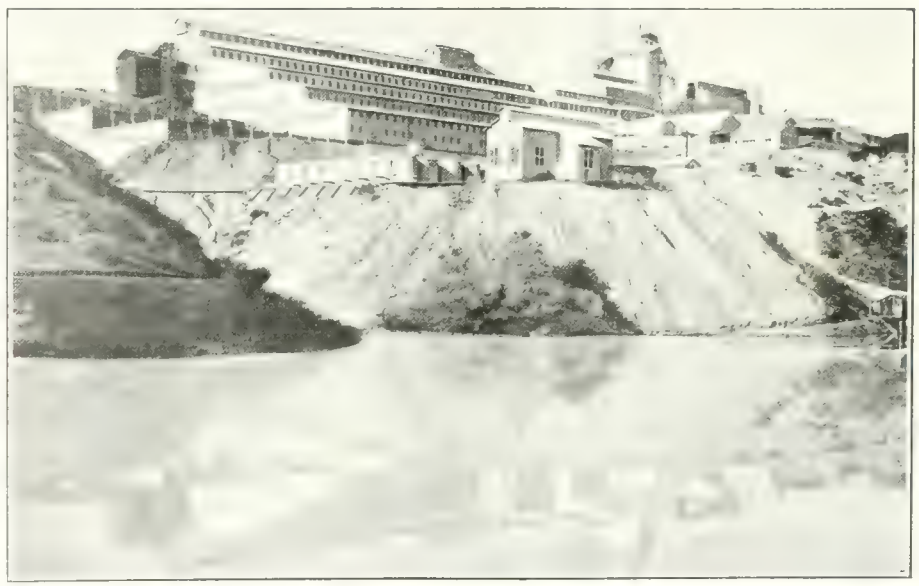
CHARACTER AND EXTENT OF OREBODY.

The Miami orebody occurs in the form of an inverted top, averaging, as at present developed, 500 feet thick, and covered by 100 to 300 feet of capping. The continuity of the ore, which is almost a solid body, makes it readily amenable to mining by a modified caving system. According to official reports there is fully developed approximately 19,000,000 tons of ore having an average copper content of 2.58 per cent. In addition there is partly developed a considerable tonnage below the 700-foot level which has not yet been made public, and is said to have a higher general average copper content than the orebody above. In fact, developments indicate a substantial increase in developed ore reserves, but the Miami management prefers to calculate its ore tonnage only when it has actually been blocked out. Consequently, it is unlikely that any definite figure will be obtainable for some time. Further, it is generally understood that lenses of high-grade copper ore have been encountered by the two diamond drills operating from the lower mine levels.

As at Ray, the disseminated ore deposits of Miami owe their origin to the intrusive diabase, and are in the nature of a contact phenomenon similar in general to other well known "porphyries," though substantially different in point of specific relation.

The intrusive diabase is responsible for the highly-mineralized area of the district limiting the "disseminated" zone, and considers (1), the primary mineralization of the zone represented by the altered schist, and (2), a probable secondary mineralization at a lower horizon. The inter-zonal region is represented by the presently determined disseminated copper ore-deposit in schist, immediately underlaying the oxidized capping.

The primary mineralization did not form workable orebodies, except locally in small veins. The workable disseminated deposits are due to secondary enrichment occasioned by the degradation



Concentrator Located on Which Reduction Is Soon to Be Now Filled With Tailing

*Mining and Metallurgical Engineer, Mills Building, El Paso, Texas.

of the lean ore near the surface, and subsequent transportation of the copper salts therefrom to a lower horizon, replacing the pyrite of the unoxidized zone by chalcocite. Progressive lowering of the surface by erosion, with attendant oxidization, has brought about constantly recurring concentration of the copper minerals, leaving the earlier formed chalcopyrite, or chalcocite, to be oxidized and its copper content carried downward to form new glance. The secondary mineralization is confined to the unaltered intrusive diabase, probably in part represented by concentrations of copper minerals at intermediate points making workable bodies of high-grade copper ore.

The granite seems to have served only in bringing about a silicification of the schist, the result of contact metamorphism. The later mineralization, resulting from the decomposition of the lean ore near the surface, enriched, in part, the included tongues of granite as well as the schist.

Pyrite and chalcopyrite are the primary minerals impregnating the altered, silicified schist; chalcocite is due to intensive secondary enrichment forming the commercial orebodies mentioned in a preceding paragraph; the oxidized copper ores occurring in parts of the Miami mines were formed in situ by decomposition of the sulphides, and therefore it is to be expected that such bodies overlay deposits of sulphide ore. The chrysocolla affords a peculiar relation to the principal disseminated deposits of the district, occurring principally to the extreme western area in the Keystone and Live Oak mines, which have been extensively developed and extracted. Strangely, the area wherein these deposits occur is confined to the region of the greatest block faulting, and evidences a probable deposition from post-dacitic mineralization, although there seems to be no absolute line of facts countenancing the theory. To the contrary, there seems to be no positive proof of sulphide mineralization later than the dacite.

MINING AND DEVELOPMENT.

The Miami company in developing its orebody did not rely upon the modern plan of determining the extent and value thereof by churn-drilling, but preferred to block out the ore in the old-fashioned manner—by means of shafts, drifts, raises, and so forth. Consequently, in lieu of carefully compiled statistics outlining the "actual" ore tonnage estimated from drill-hole records the Miami orebody was carefully developed and the ore actually "blocked out" in such manner that the estimates of tonnage, and average copper content, were as correct as mining practice could make them. Aside from this marked advantage the actual development has greatly anticipated the mining requirements, and while it appears extravagant to expend too much capital in developing the mine in advance of mill requirements, as the Miami management has done, it suggests unusual foresight when compared to the practice indulged by some companies in calculating tonnages of ore which exist only in stock-market reports and the minds of the management. Similarly, the management of the Miami Copper Company, in the process of delimiting new orebodies is not desirous of making note thereof till it is prepared to offer correct figures derived from actual development of added ore reserves.

The extraction of the Miami orebody has been begun in the upper area, immediately underlying the oxidized capping. The method of mining employed in this area is by square-setting and slicing; the principal object sought is the extraction of the ore immediately underlying the capping which must be mined now, if ever. No pillars of ore are left in the area mentioned, the plan of forming a thick mat of timber between the capping and the ore keeping them separate when the caving is in complete operation, and incidentally affording a high percentage of ore extraction, with a minimum admixture of waste. This system of mining in the upper stopes occasions a relatively high expense for timber, amounting to about 20 per cent of the total cost of mining, which latter ranges from $1.10 to $1.30 per ton of ore extracted.

The Miami orebody is developed by four shafts, commonly termed Nos. 1, 2, 3 and 4, respectively. Shaft No. 2 is sunk into the supposed center of the orebody; shaft No. 4 is about one-fourth mile eastward from shaft No. 2 and was sunk in the mass of conglomerate forming the ridge upon which the mill was constructed. Shafts Nos 1 and 3, are merely development shafts in comparatively new areas. Shafts Nos. 2 and 4 are over 700-feet in depth; the former being used principally as a development shaft serving the lowest levels of the mine, and as supply entry, the latter being the main hoisting shaft of three compartments through which all ore for the mill is drawn, and as a manway. Individual steam power plants are used at all shafts. Main shaft, No. 4, is equipped with two Nordberg steam hoists; one, a double-drum hoist operating 7½-ton skips in balance serving as the main ore hoist for the mill; the other, a smaller Nordberg steam hoist serving the third, or manway, compartment of the shaft.

The first mine-level is driven in ore at 220-feet below the surface. The main haulage levels are at 420-ft. and 570-ft., respectively, and intervening levels are 50-ft. apart. Later a level will be opened at 720-ft. All levels between shafts Nos. 2 and 4 are connected, and connections will later be made between those shafts and Nos. 1 and 2. The mine is blocked out in 50x50-ft. sections, each block having two chute raises on each side for transferring ore from the upper levels to the main working levels. All of the ore is taken from the three upper level sections of each block, 25x25-ft. being blasted into the chutes, in which manner the ore in the upper levels can be extracted without permanent timbering. The same plan will obtain with reference to the lower levels, although no ore will be extracted from the lower levels until the area above the 420-ft. level has been mined. The haulage levels at 420-ft. and 570-ft., respectively, are electrified, the ore being handled in electrically-driven ore-trains of six cars each to the main hoisting shaft, No. 4, where it is automatically dumped by placing the ore cars in tipples, the ore dropping into an ore-pocket, 30x50-ft. dimensions, by the side of the shaft from which the ore passes through chutes controlled by air operated gates into the 7½-ton skips, whence it is hoisted to the surface and automatically dumped into the ore-receiving bins near the head-frame, and immediately above the coarse-crushing plant.

Throughout, the management has done highly creditable work, and every effort is put forth to protect miners and other employees working underground by ample timbering. Further, Americans are given preference in the matter of employment over foreigners. Altogether there is no evident indication of attempting to sacrifice either human lives by faulty methods, or the efficiency of the employees by creating a race prejudice. The result has been eminently satisfactory to all concerned, and, there is not, among the many companies engaged in the mining of large deposits of disseminated copper ores, one that has succeeded in improving the morale of its skilled labor to the same degree that has the Miami Copper Company.

THE MIAMI CONCENTRATOR.

The company's concentrator is situated on the ridge immediately south of and adjoining the No. 4 shaft head-frame. In point of structural excellence, and mechani-metallurgical efficiency, it has no superior among the many types of mills treating the low-grade disseminated copper ores. The mill is unusually spacious; perfect interior lightning is afforded, both by day and night; the launder, shafting, and belting plan is excellent; and of particular interest is the fact that the premises are scrupulously clean. One may go through the Miami

mill without fear of either physical injury, or soiling one's best clothes. Further, the mill is arranged so that, should it be necessary, at any time, to effect changes in the machinery (either through permanent change in the qualities of the ore, or improvements in the art of ore-dressing), it will be an easy matter. The additional cost of construction of the mill is more than off-set by the marked advantages afforded in every respect, and, in fact, the cost has not been excessive when this mill is compared to others of inferior construction.

Power Plant.—The central power plant is located on the flat below the concentrator, where it may be reached by the railroad. The building is constructed of steel and reinforced concrete, 75x265-ft. dimensions.

The steam-plant consists of three batteries (two water-tube boilers of 600-h.p. each, forming a battery) of boilers, all oil-fired. Feedwater and oil is supplied by compound Fairbanks-Morse pumps. A complete system of economizers is installed to care for the waste-heat from the boilers, thereby reducing the fuel expense to a low figure.

Power is generated by three four-cylinder, triple-expansion, Nordberg-Corliss engines, having high-pressure cylinder of 19-in., intermediate cylinder 37-in., and two low-pressure cylinders of 40-in., all having a common stroke of 48-in. Crocker-Wheeler, 25-cycle, 1200 K.V.A., 6600-volt generators are direct connected to the driving shafts of the Nordberg engines. Steam is delivered to the engines at 185-lb. boiler pressure, and 100-deg. superheat. The engines operate at 107 revolutions per minute. Electric power from this central plant is transmitted to sub-stations at 6600-volts, and transformed to 500-volts for use in the mines and mill.

Two four-cylinder, triple-expansion, Nordberg air compressors, with a rated capacity of 4000 cu. ft. of air per minute at 90-lb. pressure when the engines are operating at 100 revolutions per minute, supply the necessary compressed air for underground mining machinery. Two four-cylinder, triple-expansion, Nordberg condensing engines care for the water circulating system. Two 100-k.w. Nordberg exciting engines care for the larger electric generators.

Water Supply.—Water is obtained from the Old Dominion Copper Company, at Globe, about seven and one-half miles southeast from Miami. The water from the Old Dominion flows to Burch station, about midway between Globe and Miami on Pinal creek, and about 175-ft. lower than the mill. The Burch pumping station is equipped with two Nordberg electric pumps. Each of these pumps is capable of delivering 1600-gals. of water per minute when operating at 150-revolutions per minute. The pumps are electric-driven by 400-h.p. motors using current direct from the transmission line at 6600-volts. Additional water is supplied from numerous bored wells, operated by compressed air, the power being supplied by Ingersoll-Rand air compressors. The Old Dominion supplies about 2,000,000 gallons daily, and the driven wells furnish a variable quantity of from 300,000 to 500,000 gallons per diem. An elaborate tailing dewatering plant, described in a later paragraph, effectually recovers about 85 per cent of the mill water used, thereby considerably reducing the water supply expense. The expense for water at present amounts to about 5 cents per ton of ore treated in the concentrator.

Mill.—The ore hoisted through main shaft No. 4 is dumped, automatically, from the skips into steel ore-bins immediately adjoining the headframe. From these ore-bins the ore is passed over grizzlies having 2-in. spacing, the undersize going directly through two sets of 24x52-in. spring rolls, reducing to ¾-in., and the oversize passing through two No. 7½ Kennedy gyratory crushers, being reduced to pass a 2-in. ring. The crushed material from the Kennedy crushers goes through a 4x12-ft. revolving trommel having ¾-in. perforations, the oversize from which passes through the 24x52-in. rolls. All material handled in the coarse crushing department is reduced to pass ¾-in. ring, and then is delivered to a 30-in. by 279-ft. inclined belt conveyor which elevates the crushed ore to a point above the concentrator fine-ore storage bins where it discharges upon a horizontal belt-conveyor 30-in. by 329-ft., the latter distributing the fine-ore to the six cylindrical steel ore-bins, each of 1,000 tons capacity. The horizontal belt-conveyor serving the mill storage bins is equipped with an automatic tripper, traveling back and forth on a track along the conveyor line.

The main shaft, No. 4, the crusher building, and fine-ore storage bins all are situated on a ridge above the power plant. In line with the bins, and upon the side of the hill, is the concentrating plant. Under this arrangement the ore, during the concentration, is constantly being carried downward by gravity, thus passing through the process with no further necessity for mechanical handling.

Each fine-ore storage bin is equipped with an automatic disc feeder and ore sampler, which regulates the feed to the 14-in. by 24-ft. belt-conveyor serving a set of 16x42-in. spring rolls, or, in one or two sections, Burch rigid rolls. The automatic disc ore-feeder and sampler is arranged so that every fifth revolution of the disc a portion of the ore is diverted as a sample. By this arrangement an analysis of the ore may be made at the time the ore is delivered for treatment, and the nature of the treatment required determined

Throughout the plant, that is, where the necessity exists, installation of modern automatic machinery is made. Powerful electro-magnets have been placed along the line of the belt-conveyors to the mill storage bins, for the purpose of eliminating scraps of iron and steel intermixed with the mine-run ore, which, if not removed would seriously damage the crushing machinery. Also, weightometers have been installed both on the large belt-conveyors serving the fine-ore bins, and similarly, on the conveyors serving the fine-crushing department of the mill. This latter arrangement is very advantageous, as it insures a means of carefully checking the ore tonnage handled.

Details of Operation.—The following outline briefly describes one section of the concentrator, all others, (except as noted hereinafter regarding changes yet to be made) being duplicates thereof:

From the belt conveyor serving the fine-ore bins, the material is delivered to 16x42-in. rolls set to reduce the ore to one-eighth inch. Some of the mill sections are equipped with Burch rigid rolls, others with spring rolls. The crushed material from the rolls is dropped onto two 24x48-in. traveling belt screens of 16-mesh, the undersize from which goes direct to two 10-spigot Richards pulsator classifiers, the oversize passing through three 8-ft. Hardinge pebble mills (in two sections of the mill through 6-ft. Chilian mills) reducing to pass 12-mesh. From the Hardinge mills (or Chilian mills) the pulp is distributed to the two 10-spigot Richards classifiers. The overflow from the classifiers goes to two 12-ft. conical settling tanks, and each of the ten classifier spigots serves a different group of Deister sand tables. The three first spigots each serve individual Type A, Deister Simplex sand tables; the remaining seven spigots each serving individual Type 2, special size, Deister sand tables. The sand tables make a clean concentrate which goes directly to the concentrate storage bins for dewatering.

Formerly the first three sand tables made no middling, the tailing therefrom going to a 6-ft. Hardinge pebble mill in the No. 1 tunnel (directly underneath the sand table floor), being reground to pass 14-mesh, thence treated on two Type 2, special size, Deister sand tables, the latter producing a clean concentrate which was delivered to the concentrate storage bins, and the tailing passing into the race. Also, the tailing from the remaining seven Deister sand tables was sent to the first four Deister slime tables on the second floor of the mill, now represented by the treatment of the over-

flow from the two 12-ft. settling tanks in sixteen 6-ft. settling tanks serving sixteen individual Deister slime tables, the first four of which were then reserved for the treatment of the combined tailing from the sand tables, and the thickened pulp from the first four 6-ft. settling tanks. Later the flow-sheet was revised as shown in the accompanying abbreviated flow-sheet diagram of one unit.

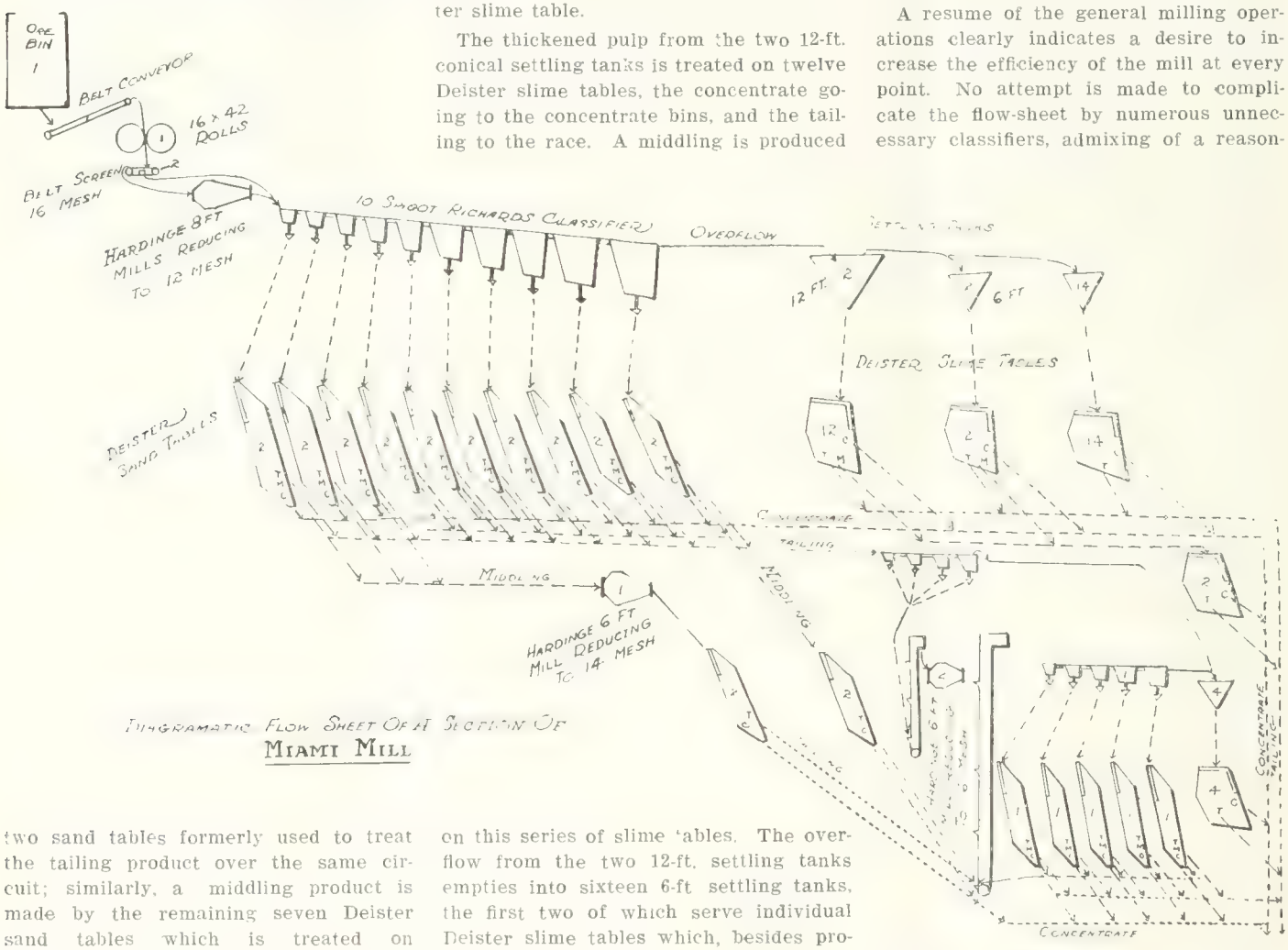
The present flow-sheet considers the treatment of a coarse middling from the three first Deister sand tables in a 6-ft. Hardinge pebble mill regrinding the pulp to pass 14-mesh, then treating on the two sand tables formerly used to treat the tailing product over the same circuit; similarly, a middling product is made by the remaining seven Deister sand tables which is treated on two Type 2, special size Deister sand tables installed on the second floor at the head of the Deister slime tables formerly treating the tailing product from the same series of sand tables on the first floor.

The tailing from the entire series of ten sand tables fed by the Richards classifiers now is subjected to further treatment, as will be noted in the diagram. This retreatment plan considers the classification of all the tailing in a 4-spigot Richards classifier, used solely for the purpose of dewatering, as all four spigots serve a small bucket elevator, the overflow from the classifier going to the large dewatering plant at the foot of the mill. The pulp from the 4-spigot classifier is elevated to two 6-ft. Hardinge pebble mills, regrinding to approximately 16-mesh. This reground pulp is then elevated by a second bucket conveyor to a 5-spigot Richards classifier, each spigot of which serves an individual Type 2, special size Deister sand table, the latter producing a concentrate, middling, which is returned to the 5-spigot classifier, and a tailing.

The overflow from the 5-spigot classifier goes to four 6-ft. conical settling tanks, each of which serves an individual Deister slime table.

The thickened pulp from the two 12-ft. conical settling tanks is treated on twelve Deister slime tables, the concentrate going to the concentrate bins, and the tailing to the race. A middling is produced on this series of slime tables. The overflow from the two 12-ft. settling tanks empties into sixteen 6-ft settling tanks, the first two of which serve individual Deister slime tables which, besides producing a concentrate and tailing make a middling, the last mentioned product combining with the middling from the twelve tables served by the 12-ft. settling tanks and being treated on a series of two Deister slime tables in tunnel No. 2, immediately beneath the slime table floor.

The first tailing outlet is from the group of all the slime tables, the product from the groups of sand and slime tables (with the exception of the last fourteen slime tables on the second floor) being subjected to retreatment as noted in the diagram.



Diagramatic Flow Sheet Of A Section Of Miami Mill

However, in considering the present flow-sheet it will be noted that the treatment of the tailing from the entire series of sand tables in the mill is an improvement which is worthy attention, affording as it does, an extraction of copper from the tailing which otherwise would be lost. The general plan of the plant built to retreat the sand table tailing evidences the only attempt to employ a closed circuit in the entire milling equipment, and, was so arranged because of insufficient space below the main building to permit of an extension of the gravity plan.

EFFICIENCY AND ECONOMY AIM.

A resume of the general milling operations clearly indicates a desire to increase the efficiency of the mill at every point. No attempt is made to complicate the flow-sheet by numerous unnecessary classifiers, admixing of a reasonably clean middling and tailing with new pulp followed by treatment over one circuit, or the regrinding of pulp, tending toward excessive sliming. To the contrary each product, other than the concentrate produced, is subjected to a treatment peculiar to its particular requirement, and best suited to extract the maximum percentage of copper mineral contained from the pulp. This feature is, perhaps, best outlined in the flow-sheet diagram given herewith.

The most remarkable change in the mechanical equipment of the mill has been the substitution of Chilian mills

by Hardinge pebble mills. The conditions obtaining a few months since (when it was deemed advisable by the management to remove the Chilian mills on account of their comparative inadaptability to reduce the pulp to the desired fineness without excessive sliming), led to the installation of the Hardinge mills. The change has, however, been made gradually, a thorough test of the relative merits of both types of grinding machines having been made, under actual operating conditions. The greater mechanical efficiency, and more economical operation of the Hardinge mills led to their adoption; consequently, so soon as the changes can be made in the two other units of the mill now using Chilian mills, Hardinge mills exclusively will be used. Comparing the cost of the lining and pebbles of the Hardinge mills with the cost of steel and screens of the Chilian mills it is said that a saving of 3 cents per ton of ore treated is effected by the use of the former.

The question of an economical water supply for the mill has necessitated the construction of an extensive dewatering plant below the mill to recover as much water as possible from the tailing. Briefly described the plant consists of four sets of large wooden conical settling tanks arranged in series of three each. The tail race empties into these tanks, the overflow going to eighty (80) 12x20-ft. concrete tanks for further clarifying, and the thickened tailing to the tailing elevator pit. This system permits of the recovery of practically 85% of the total water used in the mill.

Local conditions do not permit the easy disposition of the mill tailing; consequently, when the gulch immediately south of the mill is filled it will be necessary to construct a flume to transport the waste material over into the adjoining canyon. In anticipation of this circumstance the company has constructed a 75-ft. tower containing four bucket elevators, which elevate the tailing to a flume distributing to the tailing pond in the first canyon, and will care for the tailing disposal into the second canyon when necessary.

NOT ALWAYS ABOVE CRITICISM.

The Miami Copper Company is, perhaps, the best representative, with the exception of plants at Morenci, of modern mining and milling practice as applied to the treatment of the disseminated copper ore deposits. It has not always been so, but through no fault of the constructing engineers. The Miami Copper Company has not been above criticism, much of it well deserved. However, the criticism directed toward the management upon the ground of extravagance in the matter of constructing a "palatial" ore-dressing plant was unwarranted. A personal visit through the mill will serve to correct any such impression. The mill is, in no sense, "palatial," but merely is designed to effectively care for any future contingency in the matter of material changes in ore-dressing methods, and to care for the present operation of the equipment in the most efficient manner possible. Such action is highly commendable.

During the initial operation of the concentrator, the management considered the treatment of a maximum ore tonnage, apparently regardless of efficiency. In part this action was due to the fact that there existed at the time a large tonnage of ore in the stock pile; consequently, a treatment of tonnage through the mill approximating forty to 100% overload was practiced for a considerable period of time. A reconsideration of this method soon followed due (1) to the fact that, when the stock pile had been treated it was ascertained that the mine was not planned to output but 3,000 tons daily except by sacrificing a large tonnage of commercial ore, and (2) failure to recover a percentage of copper mineral approaching the saving effected on a normal tonnage basis. In short the mine and the mill were planned to care only for a normal tonnage of 2500 to 3000 tons daily, and an excess over that quantity, as might have been expected, resulted in serious economic losses. The readjustment might, therefore, be said to have been compensating.

Further, the Miami Copper Company has not always in its milling operations been prepared to effect the high percentage copper recovery at present being made. Trivial changes in the practice have been necessary from time to time, but every change made has been productive of satisfactory results. Extremes have been avoided, and the engineers in charge have been careful to preclude the possibility of complicating the mill flow-sheet; in fact, they have evidenced unusual foresight throughout, so that each successive change has tended to increase the efficiency of the mill rather than the contrary.

The general character of the Miami ore necessitated minimum sliming if a satisfactory recovery of the copper mineral was to be effected. Consequently, Burch rigid rolls were installed to care for the first stage crushing, on account of their producing a uniform granularity of the pulp. The uniformly granular pulp from the Burch rolls was delivered to Chilian mills for further regrinding, with unsatisfactory results, as the Chilian mills slimed the product which it was intended to maintain in as coarse state as possible consistent with the liberation of the copper mineral from the gangue. Therefore, in view of this apparent counteraction, the management sought a grinding machine to replace the Chilian mills, resulting in the adoption of Hardinge pebble mills as hereinbefore outlined. These latter mills are now in successful operation, and, beside a marked saving in maintenance, are mechanically more efficient in connection with the fine grinding of the ore, without excessive production of slimes.

Concerning the Burch rigid rolls it might be apropos to state that the rigid rolls employed in the Miami mill have given excellent service, the fact notwithstanding that spring rolls have, in several sections of the mill been substituted therefor. Briefly stated, the reason for the change mentioned was due to the fact that the rigid rolls were not adapted to the handling of heavy overloads—having been designed to care only for the normal tonnage for which the mill was designed. Now that conditions have returned to normal it is probable that the rigid rolls will be reinstalled throughout the mill.

The entire six sections (each of 500-tons daily capacity) of the Miami mill are at present in operation, and it is probable that, later, the three additional units which were to have been constructed during 1912 will be completed, thereby giving the company a nominal milling capacity of 4,500 tons daily.

Miami, operating at its normal capacity of approximately 3,000 tons daily, and treating ore averaging from 1.95 to 2.58% copper per ton, recovers on the average 77% of the copper mineral contained in the ore. It is quite probable that the percentage of recovery will shortly be increased to an average of 80%.

The concentrate produced is shipped to the Cananea Consolidated Copper Company's smeltery at Cananea, Sonora, Mexico, for further reduction. Dependent upon local economic conditions cost of production ranges from 9.57 to 10.61 cents per pound copper.

AN UNUSUAL FEATURE.

An unusual feature in connection with the operation of the Miami Copper Company's concentrator, and which to my knowledge does not exist at any other milling plant in the west operating upon the low-grade disseminated copper deposits, is the circulation of daily reports among the employes in every department clearly outlining the results obtained. Tonnage treated, average head

and tail, together with recovery effected, is given unreservedly. Bulletin boards are conveniently placed in each section of the mill, and the reports attached thereto give in detail not only the results obtained for the entire day, but a segregation into the three respective shifts, comparing the operations for each respective shift of eight hours. Therefore the employe is taken into the confidence of the employer, and aside from his appreciation of the fact, which results in a more satisfactory relation, he is at all times cognizant of what is expected from him and therefore, in view of the information which is at his command, he is better prepared to perform his duty with maximum efficiency. In short, the interest of employer and employe is mutual, and this mutuality carries with it the conviction that the management is equally as liberal in the diffusion of necessary data covering its daily operations, as it was in its expenditure of capital to construct a "palatial," but nevertheless a superior, modern concentrating plant.

IN CONCLUSION.

Generally it is understood that, when the Inspiration mill is placed in commission, and is producing concentrate, a smeltery will be constructed in immediate proximity to the Miami-Inspiration mills to handle the output of that district. This arrangement precludes the construction of a railroad from Hayden principally for the purpose of shipping the concentrate to the Hayden smeltery, and will shut out the Guggenheims from the district, unless they succeed in gaining control of the entire Miami-Inspiration holdings for which they have been negotiating for the past year.

An interesting point in connection with the proposed purchase of the Miami Copper Company by the Utah Copper Company is current, both at Miami and at Ray, to the effect that the Utah Copper Company management would not consider the purchase of the Miami holdings, primarily on the grounds that the milling equipment was inefficient, and the expense of remodeling the concentrator would be too great. Whether credence can be given the rumor or not, it contemplates a very interesting discussion as to the efficiency of any of the concentrating plants controlled by the Utah Copper Company when compared to the Miami mill.

It should be borne in mind that Mr. H. Kenyon Burch, the engineer, who, with his assistants, designed the Miami concentrator, is not a novice in the construction of concentrating plants, but has designed and constructed more large mills of types thoroughly suited to the character of the ore to be treated than have the entire engineering force of the Utah Copper Company. Mr. Burch's mills are as efficient as modern engineering can make them, and his ability along this line is, perhaps, best reflected in the fact that he knows the requirement in advance of constructing and, therefore, when the mills designed by him are placed in operation THEY DO NOT HAVE TO BE REMODELED.

To the contrary, the gentlemen who designed the plants of the Utah Copper Co., Chino Copper Co., and Ray Con. Copper Co., etc., seemingly have no respect for established methods of engineering. Otherwise in lieu of the application of the same general milling plan to the widely different types of disseminated copper ore deposits of Utah, New Mexico, Arizona, and so forth, the mills would have been planned to meet the conditions peculiar to the character of ore to be treated. As it is, the ore must adapt itself to the milling plan rather than the adaptation of the mill to the ore, thereby occasioning a constant remodeling of the mills in order that a recovery of but little more than half the copper content of the ores treated might be made.

Miami is representative of what modern mining and milling practice should be, and great credit is due Messrs. Channing, Burch, Lawton and Gottsberger, and the other engineers who are responsible for the efficient operation of the property. Of particular interest is the marked appreciation of Mr. Burch's engineering ability through the engagement of his services to design and superintend the construction of the new Inspiration concentrator of 7,500 tons daily capacity, a complete description of which will be published in Mines and Methods in a later issue.

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The local daily press a couple of months or so ago gleefully told how the Utah Copper Company had been able to secure several hundred Mexicans to take the places of the strikers on the steam shovel benches of its mines at Bingham. On the tenth day of December every mother's son of them—over 400—quit and left the camp. And the daily papers made no mention of it.

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An Alaska mining news item in a recent issue of the Engineering & Mining Journal says: "The Perserverance stamp mill, four miles up the Silver Bow Basin, was destroyed by fire, December 3. The mine force of 150 men was able to save the powder house and adjoining buildings. The mill, which was an experimental one, will not be rebuilt." Thus it will be seen that no apologies in the near future will have to be made for lack of reports concerning the real, recoverable values—or lack of them—in the ores of the Alaska Gold Mines properties, chief of which is understood to be the Perseverance. The destroyed mill is the one that was to be run—and supposedly was running—to capacity during the development of the properties as a "testing" plant. However, the "big noise," the powder house, was saved.

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Pipes connected with dumps and tanks in mills situated in cold climates should be so arranged that they can be drained after use, especially where used in intermittent work, such as in vacuum filtration of slime.

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It has often been observed on return air-ways, where the air is warm and dry, that the lamps do not burn so brightly and the workmen become dry and thirsty. It is said that the parched air absorbs the moisture from the body, and unless they have ample drinking water, their blood becomes thick and hot, resulting in feverish, painful lassitude. The same warm air, before reaching the lamps has been absorbing water in its journey, and is thus so heavily charged with watery vapor that its oxygen is diluted, which results in dull and sickly lights.

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Although previously considered insoluble in sulphuric acid, even when boiling, it has been shown that platinum is actually soluble in it to a slight degree (Brass World, November, 1912) and that boiling sulphuric acid will dissolve appreciable amounts from the vessels in which it is heated.

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All commercial explosives owe their power of doing work to the expansive force of the great volume of gas into which they are converted at the occurrence of the explosion. The pressure exerted by this gas in the drill hole or other confined space in which the explosion is brought about is what makes explosive substances of value in mining or other industries, and is the primary cause of all those manifestations of energy that follow the firing of a charge. Common black blasting powder, on explosion, produces about 390 times its own volume of permanent gases; 40 per cent dynamite produces about 530 times its own volume of permanent gases; and nitroglycerin produces somewhat more than 747 times its own volume of permanent gases. These proportions of volume of gases to volume of explosive are those that would be found if the gases were measured under normal conditions of temperature and pressure, but at the moment of explosion the gases are highly heated, and therefore tend to occupy a volume much greater than the figures given.

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CONTENTS:

"MANAGING EDITOR" JACKLING

Quoting a long and senseless yarn about the Alaska Gold Mines from the Wall Street Journal, the Salt Lake Tribune of the 13th opens up as follows: "D. C. Jackling, vice-president and managing editor of the Alaska Gold Mines Co., who is in New York, says the company's affairs are proceeding smoothly and much more rapidly than expected." It has been generally known that Mr. Jackling was vice-president of the company, and while it has been suspected all along that he also was "managing EDITOR," the fact that such an official designation had been created for him by the company, was not given out publicly—so far as we know—until the Tribune released it on the date stated. But it's all right; and it sounds all right. Besides, we are ready to admit that the title covers perfectly the most strenuous part of his duties in behalf of the company.

SMOKE MAKERS VS. CITY BUILDERS

It has been shown in these columns by government records that foggy, smoky days in Salt Lake City have been just ten times as frequent since the smelters began operations in the valley as before. A number of the world's scientific authorities have been cited to show just how the smelter dust, fume, smoke and gas work their destruction and increase the smoke and fog over Salt Lake City.

It has further been shown by cost figures of smoke damage, compiled by experts in the U. S. Bureau of Mines, that the average annual damage in cities from foggy and smoky days is seventeen dollars per capita, which is practically two million dollars a year in Salt Lake City. It has been shown by local weather bureau records that an average of sixteen and one-fourth out of twenty foggy or smoky days a year in Salt Lake City are unnatural, and undoubtedly the direct result of smelter smoke, causing a loss of $1,625,000 a year above the natural or legitimate cost of smoke.

Adding to this the State Game Warden's figures of $208,333 a year, as the value of the wild fowls destroyed annually by smelter poisons, we have a charge against the valley smelters of $1,833,333 a year of actual property destruction and additional expense.

Tourists who find here a foggy, smoky unattractive city, spend less time and less money with us than they would in a clean, cheerful city, as interesting naturally as is Salt Lake City; and the demand for business property and city homes is much less than it would be if the smoky, foggy days were diminished, and thus the actual value of our property is below what it rightfully should be.

A "City of Opportunity" must be a "City Beautiful;" a suitable place for handsome homes; a peaceful place for comfort-seeking older folks, and a clean, daylight mart for the opportunity-seeking younger folks; and finally, it must be a place where its own builders may dwell in cleanliness and happiness, with never a diminishing view, or a lack of the fresh air, which taught them to love the place in the beginning.

Salt Lake City is, naturally, just such a place!

The smoke and fogs are unnatural and unnecessary. We deserve them no more than we deserve a pestilence of disease. They can be greatly mitigated if not almost entirely stopped by the removal of the smelters from the valley. And for those who may not know, it should be said, the "hardship" on the smelters to move is really a comparatively small matter, so say those in a position to know. The equipment is outdated in many respects, and it is well known that the added efficiency from modern machinery and methods perfected since the erection of the Murray and Midvale smelters, would probably make it profitable to rebuild the plants for this reason alone, since both have been in operation more than ten years.

The annual toll paid to the valley farmers regularly for crop and stock damage, would cease, if the smelters were removed to the desert west of the Oquirrh mountains; and yet the average distance to the contributing mines would not be greatly affected; and as has been proven by the International plant near Tooele, the usual business of the smelter operation and maintenance, as a rule, need not be transferred from Salt Lake City, nor need Salt Lake City lose any important amount of business by the transfer of the smelters a few miles farther away.

It is probable that enough pressure could be brought against the owners to cause them to voluntarily remove, yet, failing in this, there is already sufficient funds and sufficient public spirit among those interested and not subservient to the smelter business directly or indirectly, to bring the legal action necessary to have the smelters adjudged a public nuisance and force them out of the valley.

Do the people of Salt Lake City and valley want it done? And do they want it enough to SAY they want it?

The business connections of many forbid their speaking their honest minds on such a subject as this, yet there are many who do not fear a boycott or

business strife, no matter what they may say against an institution so powerful as a smelter corporation; and for this reason the editors of Mines and Methods do not expect the open approval of some of the city's most influential persons and institutions, yet the editors wish to advise the people of Salt Lake City that when the proper moral support is given to the anti-smoke crusade, being waged by this magazine, the financial support, already pledged, will be promptly put into effectual action.

It may seem like a calamity to the city to be in the predicament of asking the smelters to move their plants over into the next valley; and yet, careful investigators have found that the sentiment against a further toleration of the smoke nuisance is so great and so earnest, that the loss of business men, and of scores of well-to-do and influential citizens, who will move their homes if the smelters are not moved, is really a far greater calamity, and one productive of absolutely no permanent good to the city, such as the removal of the smelters would be.

Which shall it be, the dominion of the smoke-makers or of the city's home-builders?

Thirty days ago Carl C. Herman, a guard at the Utah Copper Company's mines, decided to do what he could to make his job perpetual, so he gathered up a lot of giant powder and was making preparations to blow up some of the buildings on the property when a roommate, who became frightened at the amount of explosive Herman was accumulating, reported the matter and Herman was arrested. "The job as an armed guard during the strike," Herman is reported as having said, "was an awful soft snap and I figured that to set off a quantity of dynamite in different parts of the camp would cause the mine owners to think that the strikers were causing the disturbance." A great many "guards" are still employed by the company and, while it seems that there has never been much use for them, as far as preventing depredations by the striking miners has been concerned, there is still apparent justification in keeping some "tried and true" men to watch the rest of the gang.

[illegible] of the Utah Consolidated, is here to see the overflow of copper from the tailings in Salt Lake City endeavoring to interest D. C. Jackling, general manager of the Utah Copper, in installing the Craven slimers in the concentrators at Garfield.—Salt Lake Telegram, Jan. 26.

Mr. Craven will sure find some "overflow of copper" in the tailings at the Utah Copper plants.

UTAH COPPER'S DEFICIT

The fourth quarterly report of the Utah Copper Company for the year 1912 was released and made public about the middle of the month. It is a queer document—one that will cause stockholders to do some hard thinking and figuring on what may be expected in the future. When they read the tale of woe leading up to the management's acknowledgement of a deficit for the quarter of $82,247.90, and the manner in which it is arrived at in the financial statement, they are likely to wonder how much greater the amount would have been had the whole subject of income and outlay been properly covered.

The report shows that the amount of ore produced was 930,595 tons, the assay value of which was 1.104 per cent, or twenty-two pounds of copper per ton. The total yield in copper was 12,906,582 pounds and the total cost of production was 14.83c. per pound. The estimated average value of copper for the quarter was 15.15c per pound, thus showing an apparent profit of the difference between 14.83c. and 15.15c. or 0.32 of a cent per pound. The total number of pounds of copper produced for the quarter multiplied by this difference gives an apparent net operating profit of $39,273.18, which is given in the report as a milling profit. But just how it is figured that a mill could earn a profit when all other departments of the enterprise managed only to break even, or lose, is not made quite clear in view of the fact that no previous report has ever credited any independent profit to the mills. This alleged profit, divided by the number of tons of ore said to have been treated, gives a profit of only ABOUT FOUR CENTS per ton.

The remarkable feature of this exhibit is that the recovery appears to have been nearly fourteen pounds of copper per ton of ore treated, or about 68% of the total contents of the ore, which compares with an average of less than 60% recovery under the most favorable conditions. This apparently unusual high recovery, however, disappears when the fact is taken into consideration that in reality nearly 1,300,000 tons of ore were treated during the quarter, or about 30% in excess of the amount given in the report, as above stated, the difference being left out of consideration as representing the excessive moisture in the ore due to the unfavorable weather conditions complained of by the management. It is suggested, however, that had not the excessive tonnage been provided so as to give the management the advantage of a maximum load in that part of the plant operated, the profit would most likely have been less than four cents a ton.

Another unfortunate consequence resulting from the Bingham cold weather seems to have been in the necessity for increasing the capacity of the crushing plant to 50,000 tons a day in order to overcome the stubborn resistence of the frozen ore, as it is well known that Utah ores in temperate weather are exceedingly soft and friable. According to Manager Jackling the economic percentage of recovery to be sought in milling practice is that which is determinable only by the tonnage of ore that may be hurtled through the mills. It is therefore probable that when unfavorable weather conditions disappear it will be found necessary to raise the capacity of the balance of the milling plant to correspond with that of the coarse crushing department, the increase to be operative only in favorable weather, reserving the full power of the increased crushing plant to provide normal supply to the present tables when the ore becomes harder by winter frost.

Some of the other questions that will naturally follow a careful, serious reading and consideration of the report are:

Why should the company have kept running at all, when the management knew that to do so would not only result in a direct money loss but also in the utter dissipation of over 1,000,000 tons of ore?

And, if what Manager Jackling has reported during the month is true, namely, that it will require another two or three months to get back to normal conditions—as compared with those which have prevailed from the beginning of October last—why is the property not closed down now?

In fact, is there any excuse for the wanton waste and ruining operating practice that has prevailed at the Utah Copper properties for the last five months, (or from the beginning, for that matter) other than the frenzied determination to escape, as long as possible, the final day of reckoning?

The situation is a desperate one. There seems to be no place into which Utah Copper can edge in order to escape the storm that is gathering. It has been pictured to the world as the "greatest self-contained manufacturing enterprise of the day;" its management has been depicted as the quintescense of perfection, and its engineers the greatest in the world; its mining and milling methods have ben heralded as the acme of applied human knowledge, and the success of numerous other gigantic enterprises fathered by the same and kindred interests have been predicated and built up on the strength and worth of this one. The

completed structure—the handiwork of these "master minds" in the world of engineering skill and high finance—may be likened to an inverted pyramid (with Utah Copper representing the bottom stone) constructed of concrete blocks of huge dimensions containing disproportionate quantities of sand, cement and coarse gravel to the "units" of "water" employed, AND ESPECIALLY WATER.

PRECOCITY OF GUGGENHEIM'S

The recent purchase of large blocks of Ray Consolidated and Chino stocks by the Guggenheim interests probably has a significance quite different to that which has been attributed to those purchases. About the time of the purchase by the Guggenheims of their first large block of the shares of Utah Copper, together with convertible bonds, by which means the original financing of that company was inaugurated, they also purchased a considerable interest in the stock of the Federal Mining & Smelting Company, of the Coeur d'Alene district, Idaho. It now appears that as a condition of the purchase of the shares of that company they secured a contract for the smelting of the ores to be produced by the Federal mines for a period of twenty-one years. Of course no information was given to the public as to the terms of the contract or rate to be paid for the product of the mine; but the fact that the contract was a most favorable one to the Guggenheims and that it was secured under pressure has been disclosed in the action recently instituted in the United States court in and for the district in which the mines are situated by the majority owners of the stock of the Federal company. This action was brought to have annulled and set aside the existing smelting contract by reason of its excessive bias in favor of the Guggenheim interests. In connection with the legal proceedings it was made to appear that the contract required the payment of $22 a ton to cover transportation to Colorado or Utah points and smelting at the place of reduction, the metals being paid for in the usual way at prices based on New York quotations.

Upon the installation of lead smelting furnaces at the works of the International Smelting Company at Tooele, this state, it appears that many contracts were made for the product of other mines in the locality adjacent to the Federal company's mines upon a basis of $16 per ton, the difference being $6 per ton in favor of the producer, and which, applied to the ores produced by the Federal company, means a loss to that company estimated at $800,000 per annum, wherefore the action referred to was brought with the hope of saving this large sum to the stockholders.

We have shown in a previous issue of this magazine that as a condition to the purchase of the initial block of Utah Copper shares at $20 per share and also the purchase of $3,000,000 of convertible bonds of the company, wherewith to provide funds for the construction of large operating plants, that a contract was entered into by the management of Utah Copper and the Guggenheims whereby the latter, for a period of twenty-five years should receive $6 per ton for smelting Utah Copper concentrates, with an additional price of 10c. per unit for all silica contained in the product above a point 10 per cent below a neutral base—that is, the contract guaranteed that the iron contained should exceed the silica by ten points, in order to entitle the Utah company to the $6 treatment charge. Now, as the silica at all times exceeded the iron contents by twenty-five to thirty-five points the smelting charge at once, it was discovered, settled around $9 per ton; but finally, in order to avoid vexatious litigation which was threatened on the part of stockholders who had not been parties to this contract, the Guggenheims rluctantly agreed that the charge for smelting should in no case exceed $7 per ton, and as the iron was always more than ten points below the neutral base, the price became a fixture at $7 per ton.

At the time this contract was made the Gugenheims were receiving and treating other ores of similar but more refractory character at $4.50 per ton, without time contracts, and were offering a rate of $4 on time contracts. The difference we have shown to be equal to ¾c. a pound on all copper produced by the Utah Copper Company.

In the matter of Ray Consolidated and Chino both companies being in need of further financing—it must be presumed that the purchases of shares in these companies was conditioned upon long time contracts for the exclusive smelting of the ores to be produced by those properties and that the rates were not less favorable to the Guggenheim interests than were those contained in the contracts with the Utah Copper and Federal companies, before mentioned. Naturally it was to have been expected that taking these large blocks of stock off the market would have had the effect to greatly enhance the price of the shares and thus enable the insiders, as well as the Guggenheims, to unload the burden upon the public; but evidently they have reckoned in this respect without their host, the public having, in the meantime, become most stubbornly and offensively inquisitive in matters of investments of this character.

However, in the case of Utah Copper, the Guggenheims can throw away their more than 400,000 shares of that company and still be several millions ahead by reason of profits on their smelting contract; likewise that of the Federal Mining & Smelting Company. And in the case of Ray and Chino it will be a "cold day," even in that torrid region, when the value of the product is not sufficient to pay the smelting charge, which is the first concern of the Guggenheims, and it will only require a few years at most to recoup their outlay in that direction, even though they should fail to unload the shares so purchased on the public.

OUTLOOK FOR UTAH COPPER

In an interview with the Boston News Bureau (Feb. 11th) on conditions prevailing at the Utah Copper Company's properties, Manager D. C. Jackling was quoted as follows:

> At the Utah Copper property normal operating conditions are fast being restored, and today we are handling from 18,000 to 20,000 tons of ore per day, and that is a lot of material. * * * For the first three weeks in January we averaged to ship 14,000 tons of ore per day, and for the full month the total tonnage should be 150,000 tons with a production of somewhere near 7,500,000 pounds. This will compare with 5,975,000 pounds produced in December. The various adverse conditions previously noted put us a little behind in our stripping, and we have been compelled to draw our ore supplies from that portion of the property where the grade is a little under the average, so that I question if we get back to a maximum production of copper for two or three months.

On the 12th of this month the Deseret Evening News, quoting a report received from the East, credits Manager Jackling in greater detail concerning the grade of the ores mined than that found in his statement to the News Bureau. We quote from the News as follows:

> During December when a combination of exceedingly unfavorable conditions existed, the grade of ore treated was only 1.10 per cent, yet the company produced its copper at a cost of 9 cents a pound. This has demonstrated that on ordinary metal markets Utah Copper can earn a moderate profit by treating 1 per cent ore.
>
> It is probable that the forthcoming annual report will show that Utah Copper is continuing to increase its demonstrated ore reserves and to-day has approximately 350,000,000 tons.

The foregoing announced increase of tonnage reserves compares with a little over 100,000,000 tons similarly brought forward in the reports for each of the years 1910 and 1911, and indicates a falling off in the usual annual increase of about 50,000,000 tons.

Here we have a frank admission by Manager Jackling of the fact so frequently set forth in this journal, that at no time since the inauguration of steam shovel mining and stripping, has there been any appreciable quantity of com-

mercial ore stripped and available for extraction by steam shovels in advance of the daily requirements of the mills; and also of the further fact that as the work of steam shovel mining has, by exhaustion of the better grade of ore along the Quinn fissure in original Utah ground, been necessarily extended into the territory acquired from the Boston Consolidated, there has been a gradual and persistent decline in the copper contents of the rock, now fully conceded by Manager Jackling, as quoted above.

It has been stated by the management since the strike and adverse weather conditions intervened that, owing to the difficulty in getting experienced steam shovel operators, stripping would be practically discontinued for a time. It is a fact, however, well understood by all persons familiar with stripping operations on the property, that the difficulties encountered in transporting the capping from the top of the Boston Con. mountain down some 1000 or more feet over numerous switch-backs, has made the removal of the overburden to the company's dump field practically impossible from an economic viewpoint; so that the manager has discovered, at last, that it would be more profitable to transport the capping over the main ore-carrying lines to the mills and there have it treated as ore. And herein we find an explanation of the methods by which tonnage in this great property has—in the absence of any development of real ore—been so enormously increased during the years 1910-11, and to which increase—(we are now advised by the item quoted above) there is to be made a further addition of 50,000,000 tons for 1912.

This same system has recently been adopted by the manager of the Utah company in respect to Chino, and in this case we are advised that the manager found that, by adding about 40,000,000 tons of practically worthless rock to the 55,000,000 tons of developed ore containing 2.17% copper the reserve tonnage could thereby be almost doubled and an average of 1.83% maintained for the whole, leaving the mass still of excellent commercial grade and at the same time emphasizing the necessity for an early increase in the capacity of the company's milling plant.

Readers of Mines and Methods will remember that in a former issue attention was called to the absurdity of methods adopted by Manager Jackling—as shown in his annual reports—whereby an admitted thickness of 165 feet of capping on Boston Consolidated ground was averaged with about seventy feet on Utah, thus producing an average for the whole territory of about 105 feet. In this manner Manager Jackling assumed that by averaging a depth of capping—the cost of the removal of which by itself considered was absolutely prohibitive from any economic view—with a lesser thickness on adjacent territory an average could be produced that would make the entire problem of stripping quite feasible.

Now that the shovel operations have finally been advanced into and are wholly confined to the Boston territory, with its excessive thickness of capping, which we are advised is more nearly 200 feet than 165, the impossibility of removing this mass in order to reach the ores of meagre grade beneath with any hope of possible profit becomes at once apparent. And hence, the happy solution of a vexed problem is met in a most masterful manner by adding the greater portion of this capping to the otherwise "stupendous" ore reserves already reported, thereby increasing the amount to 350,000,000 tons and the fact that the grade of the entire mass is entirely reduced to about 1% copper is fully balanced by the increased tonnage. And Manager Jackling wisely shows, as quoted above, that the cost of producing copper from ores of this grade does not exceed 12c. a pound, from which it can be readily seen that a fair margin of profit can still be made as long as the price of copper ranges much above that point. And, as there is still some 900,000 shares of stock unissued, available for emergencies, the promised increase in the dividend rate is not without hope.

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WALKER AND JACKLING CLASH

That versatile blowhard, George L. Walker, is quoted by the Salt Lake Tribune of the 12th as saying:

"In many respects Chino has decided advantages over the other propyhry mining companies. The climate in New Mexico at an altitude of 6000 feet is admirably suited to steam shovel operations, the WEATHER BEING WARM IN WINTER, rarely very hot in summer, with exceedingly little rainfall. The ore never freezes, the distance from the mine to the mill is ONLY TEN MILES and the ore mills freely and readily yields up a relatively high percentage of its values."

The Salt Lake Telegram, of the evening before, offers the folowing official excuse for Chino's poor showing:

"The production of the Chino company in January was 3,055,821 pounds of copper against 2,545,161 pounds in December and 3,111,020 pounds in November. General Manager Jackling, who is in the east, states that this reduction is due to severe winter conditions, and to the difficulty in obtaining transportation facilities. The latter factor has hampered production for the past two months. Only four sections of the mill were in operation in January, although the fifth has been ready for operations since November.

The reader will note that Mr. Walker declares the weather is warm in winter; that the ore never freezes, and that the distance from mine to mill is only ten miles. On the other hand, Manager Jackling declares that the poor showing made in January was due to "severe winter conditions" and to the "difficulty in obtaining transportation facilities."

The paragraph in which Walker is quoted was taken from a long "spiel" in which he attempted to show justification for the investment by the Guggenheims in Chino and Ray Con. stock, evidently to stimulate or help create a public buying movement. The statements of Walker and Jackling would have sounded better had they been sprung less closely together. Such misfit declarations have a tendency to create distrust of the "engineering" ability of both gentlemen, and frighten the "lambs" who might have been heading for the shearing pen.

Alterations in the company's new mill also appear to have some bearing on the subject, rather than "severe winter conditions," as appears from the Boston Financial News' apology for December operations. It says:

"Four sections of the mill were operated continuously during the month, one section being shut down. Alterations are being made on the first three sections which were constructed which necessitate the closing down of one section at a time. The improvements occupy 30 days for each section so that it will be at least two months more before the entire plant is in operation. The fourth and fifth sections, the last completed are now in commission and are giving a high average rate of recovery."

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We find the following reference to the high price to which Alaska Gold Mines has been advanced in a market letter of a prominent Boston brokerage house: "Some are disposed to question the increase in intrinsic values of Alaska Gold as represented by the advance in quotations since its initial bow on the curb market but none question the ability of its sponsors to create a good market." The statement of fact and conclusions reached by the writer seem to be a little at variance. It is not good logic to say that SOME question the intrinsic value of the stock and in the same breath declare that NONE question the ability of its sponsors to CREATE A GOOD MARKET. Had the writer said that, NOTWITHSTANDING the disposition to question the intrinsic value of the stock, as represented in the advance of price, it was realized that the stock was so closely held by the promoters of the scheme that ITS QUOTED PRICE COULD BE PLACED AT ANY FIGURE DESIRED, he would have hit the nail square on the head.

THE TRUTH ABOUT BUTTE AND SUPERIOR

An investigation of the operations of the Butte and Superior company for January, 1913, elicits the information that there has been no marked improvement over conditions obtaining during the months of November and December, 1912, as outlined in last month's issue of this journal. This is, of course, in direct contradiction to the statements issuing from the offices of Messrs. Hayden, Stone and Company, and General Manager Jackling, that operating conditions are greatly improved. However, in substantiation of our statements that there has been no improvement, we present a brief outline of the results obtained from January, 1913, operations representative of actual conditions and derived directly from the Butte and Superior company's records.

During the past few months Messrs. Hayden Stone and Company, through their market letters, and General Manager Jackling, through published interviews in both the local and eastern press, have repeatedly and unreservedly stated that the remodeled section one of the concentrator was in successful operation and effecting an average recovery of 80% of the zinc mineral contained in the mine-run ore. Further, that upon completion of a few additional refinements to that section of the mill the general average recovery would be increased to 85%, and possibly higher.

Having the details of operation from the company's own records, as stated above, we quite naturally take exception to the remarks of the gentlemen referred to, and for the further enlightenment of Mines and Methods' readers, we present briefly in the following paragraph the absolute facts covering the January, 1913, operations:

During the month 18,400 tons of ore averaging 21.14% zinc; 1% lead; 1.8% iron, and 1.07% manganese were run through the concentrator, from which there was recovered 5,604 tons of zinc concentrate, averaging 44.6% zinc per ton, and 70 tons of lead concentrate, averaging 43.8% lead per ton. The average percentage of zinc recovery was 66.77%, and of lead, 28.12%. The zinc concentrate contained 1.73% lead per ton, and the lead concentrate contained 15.8% zinc. The average zinc tailing for the month was 9.45% zinc, according to the record. These figures represent the "doctored" report of the company's operations, and are subject to several corrections which we did not deem it advisable to make, in view of our desire to persent the quantities and amounts directly as derived from the company records. Further, on the basis of smeltery settlement for the shipment of January concentrate, if the net return per ton of concentrate produced is segregated into its component parts the gross value per ton of ore in place in the mine can be determined. Then, deducting therefrom the cost of mining and milling, exclusive of construction account and so forth, the direct production cost per pound of zinc is represented by a deficit of approximately $26,800.00 for the month's zinc output. This state of affairs considers the operation of but one of the "remodeled" sections of the concentrator, and, unless there is a very marked improvement in operating conditions, it would seem inadvisable to place section two (after its complete remodeling) into commission for very obvious reasons.

From what has been outlined concerning the operating conditions at the Butte and Superior under the present management, it is clearly evidenced that the "remodeling" of the mill along the lines of the treatment plan of the Magna mill of the Utah Copper Company has been about as successful at Butte as at Garfield—its absoltue inefficiency having been demonstrated at both plants.

The ore of the Black Rock mine (the principal property of the company's holdings) should yield readily to established methods of ore-dressing practice, and never has there been any necessity for a change in the flow-sheet as originally designed by the engineer who had charge of operations prior to the advent of D. C. Jackling and his associates. Even now Mr. Jackling is beginning to appreciate his error in connection with having remodeled the plant, and has turned the work of readjustment of the situation over to an eastern man, who doubtless will eventually return to the original flow-sheet plan of the mill if he is permitted to exercise rational initiative. We are as anxious to see conditions return to a normal basis as anyone interested in legitimate mining and metallurgical enterprises, but where the dominating interests are represented by engineering talent such as that evidenced by Mr. Jackling, and his associate, Mr. Frank Janney, we hold out no hope for the future.

PASSING OF STOCK CONTROL.

Apropos the brief outline of the physical condition of operatoins at the Butte and Superior property, it doubtless will be of interest to readers of Mines and Methods to have light on the subject of the manner in which Hayden, Stone and Company, and the Utah Copper interests financed and subsequently obtained control of the property, and that without having directly expended any capital in the proposition. Taking Butte and Superior as an example of the methods employed by the interests referred to, it readily will be appreciated that Alaska Gold, Chino, Ray Con., etc, were financed and then controlled in the same manner. In every instance the property accepted for financing has been supplied with the necessary capital requirements directly from investments made by the general public. The position of the interests promoting the deal is more clearly defined by their negotiating loans sufficient to care for the convertible bond issue, which advances are made by a few gentelmen "on the inside." The money advanced on the convertible bond issues is not a direct investment, as it affords an absolute recovery of the funds placed and a tremendous profit on the temporary loan upon conversion of the bonds into stock at par when the market price of the latter is made to rise. Controlling the bond issue, then, is tantamount to controlling the stock of the company financed through a convertible bond issue. Therefore, under the circumstances the "insiders" manipulate the stock market to suit their convenience, selling out on a high market and buying in on low market—the public at all times supplying the necessary funds. In that manner all of the properties financed by the Hayden, Stone-Utah-Copper crowd have been handled, and subsequently controlled by them without the DIRECT EXPENDITURE OF ANY CAPITAL WHATSOEVER THAT HAS NOT HAD A RETURN VALUE GREATLY SUPERIOR TO THEIR TEMPORARY ADVANCE OF FUNDS ON THE BOND ISSUE. The outline of the Butte and Superior transaction clearly illustrates this phase of the situation, and is applicable to the other properties hereinbefore mentioned

In 1911 Butte and Superior had a capitalization of $2,500,000, divided into 250,000 shares of $10.00 par value. Captain Wolvin and associates of Duluth, Minn., held the controlling stock interest in the company. The financial condition was not all that could be desired, and, in view of the desire for a new concentrator at the mine, Captain Wolvin, on behalf of the controlling interests which he represented, opened negotiations with Hayden, Stone and Company for the furcidentally obtaining cash advances on the controlling interest stock on his personal account. A substantial reserve of treasury stock remained in the company treasury, sufficient for the financing of the new mill construction, and had Hayden, Stone and Company seriously de-

sired a direct investment in the property, same could have been obtained by the direct expenditure of a few hundred thousand dollars. A direct investment in the enterprise, which would necessitate the expenditure of their own funds, was not desired by them. Consequently, arrangements were perfected for an increase of $1,000,000 additional capital at $10.00 par shares, to be used to cover a convertible bond issue of $1,000,000. certicates convertible into stock at par. Incidentally an option was taken on the controlling stock interest held by Captain Wolvin and associates, their stock having been placed under escrow agreement. Following the usual custom the bonds were offered to bona fide stockholders and refused for very obvious reasons. Therefore, it developed upon Hayden, Stone and Company to acquire the issue which they did on a basis of 90% of their par value, accepting for themselves and the "insiders" $700 000 of the bonds at a cost of $630,000, less selling commission of $30,000. The remainder of the bond issue (par value of $300,000) was distributed in the payment of the then existing indebtedness of the old company. The transaction placed about $600,000 in the company treasury.

Construction of the new mill then was begun and an opportunity occasioned, through the usual market letter procedure, to increase the market price of the shares. About May, 1912, the stock had been advanced from $9.00 (its price when Hayden, Stone and Company entered the bond issue) to $27.50, and 30,000 shares of treasury stock were sold to the public at the latter quotation. This transaction netted Hayden, Stone and Company about $75,000 in selling commission, and placed an additional $675,000 in the Butte and Superior Company s treasury. In October, 1912, the market price of the stock had reached $37.50, and 30,000 additional treasury stock were sold to the public, netting another $75,000 to Hayden, Stone and Company as selling commission, and placing an additional $975,000 in the Butte and Superior treasury. The financing of the proposition up to this point placed about $2,325,000 in the Butte and Superior treasury, and netted Hayden. Stone and Company on selling commissions approximately $180,000 in cash, at the same time leaving an unsold treasury stock reserve of about 60,000 shares to be used for further financing when required.

At this point attention is directed to the manner in which the "insiders" represented by the Utah-Copper, Hayden-Stone group recovered their original "loan" of $630,000, and incidentally realized a handsome profit on their "investment." Having held control of the convertible bond issue, and with the Wolvin stock control tied up, the stock market price of shares was advanced from $9.00 to $27.50, $37.50, $47.50 and so on to upwards of $50.00. In the early part of the stock advance (created by the insiders") they converted their bonds into stock, and— the public loaded up on it at a high market. It is stated by one of the former principal stockholders that Hayden, Stone & Company cleared for themselves and associates approximately $2,000,000 on the transaction. Having the original controlling interest stock tied up at a comparatively low price, considering the price to which the stock market had been advanced, the "insiders" exercised their option rights and acquired control of the proposition without the expenditure of any funds directly on their part, but entirely upon capital advanced by the public as hereinbefore outlined.

On February 4, 1913, Cap. Wolvin was re-elected a director of the Butte and Superior Company, but on the 6th of the same month he was retired from the board upon the final settlement of his affairs with the new management which resulted in the closing out of his holding of 8,000 shares of stock at a price considerably below the present ruling market price of a little over $30.00 a share. Knowing the property as thoroughly as he did, coupled with the fact that he knew the ultimate value of the proposition even under the most promising operating conditions, his action in the matter of letting the control pass into the hands of the present management in a manner which would net him more capital from closing out his stock on a low market than he could hope to receive in net profits from the mine if he were in absolute control, is fully evidenced.

FINAL SUMMING UP.

With a total working capital of $2,325,000 it seems that further financing will be unnecessary. However, it is generally understood in the Butte district that Butte and Superior under the present management has expended a great part of the reserve capital in the investment of mining properties having, so far as demonstrated, no economic value whatsoever. Further, the expense of remodelling the mill has been considerable and the end is not yet near. No profit has been derived from mining and milling operations, and the tendency is at present to maintain a deficit in operations unless important changes are made in the milling practice.

To avert the inevitable collapse of the entire scheme, the rumor is current (and well substantiated by a recent visit of directors of the American Zinc Company) that a consolidation of the Butte and Superior and American Zinc Company is to be attempted, followed by a flotation of the combined concern through Hayden, Stone and Company, (reputed to control American Zinc), assisted by Thompson, Towle and Company. Also, the acquisition of the Lexington group of mines controlled by F. A. Heinze is under advisement, but probably will be eliminated in view of the fact that the developed ore reserves in that property are refractory in the true sens of the word, and cannot be treated at all by any but established methods of treating complex ores—which precludes any consideration of a Jackling-Janney treatment plan. If further financing of the American Zinc Company, heretofore said to have been operated without profit, is to be effected, it will be well to bear in mind that it does not countenance the investment of capital by Hayden, Stone and associates, but the public will be asked to donate a few million dollars through the inflated stock market prices which will be made for the occasion—much in the same manner as obtained in the case of Butte and Superior, Alaska Gold and others.

The question of present market value of Butte and Superior stock is not difficult to determine from what has been said hereinbefore. The future will show no improvement under the present management. The mine with a life of approximately five years will not afford the Utah Copper contingent of "engineers" sufficient time to complete its experiments to determine a method of efficient treatment which will recover the promised 80 to 85 per cent of the zinc. Remodeling of the mill will require at least that much time, and when finally a return to safe and sane methods of milling practice is effected the greater part of the present orebody will have been several miles removed down the valley from the present site.

Considered from the point of normal operating conditions under an able management, assisted by a capable staff of engineers, the property should return in profits the original $3,500,000 capital investment plus five dividends of 10 per cent each.

In the meantime it appears, according to parties just from New York, that President MacKelvie has labored under the impression that Manager Jackling was effecting a saving of eighty per cent at the Butte and Superior mill, and upon receipt of advice from outside parties that but sixty per cent was the absolute figure, went up in the air. Thereupon Allan Rodgers, mill expert, and two other New York engineers, were sent out to fix matters up—but they will be unsuccessful.

FOLLOWING THE SMOKE TRAILS

Reasons For The "Smoke" And Fog Conditions In Salt Lake Explained. Tremendous Money Costs To The People.

By J. CECIL ALTER.

Twelve autumns ago after passing for the first time through the broad, bright streets of Salt Lake, mounting to the crown of Ensign Peak to get a better conception of the most wonderful picture of out upon a billowy sea of smoke and fog, I realized that the loved one had passed away, into the great beyond—beyond the fog somewhere, discernible only by its faint noises coming up through the gloom.

View looking southwest from Boston building roof—ominous smoke layer over city, light easterly wind, continuous dense fog or "smoke" from Wasatch to Oquirrh mountains south of Salt Lake City; a few tips of Oquirrh mountains showing bright and clear above the valley fog layer; the more southerly Oquirrh mountains are behind the deeper fog or "smoke."

the plains, my memories of the stockyards district, Chicago, faded far away as I saw spread out before me the foliage-trimmed, sky-kissed, "New Jerusalem;" a city that lay foursquare in the September sun—yet like the holy city of revelation, it semed to have "no need of the sun, neither of the moon to shine in it, for the glory of God (nature) did lighten it." I had come west seeking the light of a new day—a clear day, and before the neighborly sun closed its eyes beyond the lake at the end of my first day here I was convinced that indeed, as declared the Mormon prophet, "This is the Place!"

But another day was soon to dawn, dimly, and as the gray, poison smoketrail springing up in birth from the center of the valley, began to curl and entangle its endless self over the valley with increasing density day after day, the dawning of the new days became more and more a "deed of darkness;" a dismal transition from the night to the day.

View looking west from top of the Boston building, showing dense fog with top limit well defined, light southerly wind was blowing and has been blowing several hours. The dense fog or "smoke" appears to exist independent of the smoke from large stacks. THE SMOKE FROM THE D. & R. G. SHOPS BURSTS UP THROUGH THE REAL FOG AND IS BLOWN AWAY AS TRAIN SMOKE at extreme right and left of picture.

And so again, recently, as I wandered up the slope, out of the latter-day smoke to the resting place of old on Ensign Peak, north of the city, in quest of the lost "city of high ideals," and looked

It was then my nostrils were cleared of their sulphurous, sooty breath for a spell and mentally I saw the tragic picture of a buried Pompeii, overcome by a brick-built volcano, spewing sulphurous lava fumes; and after witnessing the glory of a golden sunrise over the Wasatch—a picture no longer the property of Salt Lake City—I trudged grimly back into the fog, recalling with great vividness, the similar fate of Biblical Sodom, whose reckless desires for material and sensual advantage had, like the business-getting desires of Salt Lake City, resulted in a rain of brimstone, and a day without a sun.

The terrible truth of this single experience is set forth in the record of foggy, smoky days maintained for forty years in Salt Lake City by the United States Weather Bureau; and a casual inspection of this record in the accompanying table, reveals a tale that is stranger than any fiction, and one which cannot be told too often for the good of the town.

In connection with this table of foggy or smoky days it must be stated that the Weather Bureau officials record only the fog or smoke that is a distinct phenomenon, and makes no special mention of those scores of days throughout the year when all the mountains and most of the valley are obscured by the dull gray, view-deadening haze, confining its entries only to those days when objects beyond a half mile are obscured.

Practically all the fogs recorded from 1891 to 1901 inclusive were of the moist

kind, which occurred largely at night, because of the high barometric pressure, and the general coolness of the layers of air, due to radiation and to the flow of cold air into the valley from the canyons. This sort of fogs are usually of the cleaner, though moister, kind. Such fogs were quite as common in the last eleven years as in the previous eleven years, and the typical morning and day fogs and smokes have been added. The first-named variety of fogs will occur in other valleys and over other cities of Utah quite as readily as over Salt Lake City, and general records by government observers show these to have occurred simultaneously in Salt Lake City, Provo, and Ogden, and other places; but the latter kind: the dirty grimy sulphurous smoke-fogs, are the sole property of Salt Lake City.

Of the 221 fogs recorded in the past eleven years, less than five per cent began at any other time than in the early morning, when the greatest cooling of the smoke and smelter particles took place. They also always occurred after long-continued southerly winds, blowing from the smelters. In general there has been snow on the ground in most of these fogs, to add to the atmospheric moisture by evaporation. If there was snow on the ground and no fog occurred, it was an unusually warm morning, with perhaps a great deal of wind movement. Practically all cold winter months since 1902 when there was snow on the ground showed fogs or "smokes."

There were comparatively few fogs recorded during the winter of 1904-5 it will be noted. That winter averaged 2.2° daily above the normal temperature; and out of the 90 days in December, January and February there were only 23 days when an appreciable or measurable quantity of snow lay on the ground in the city at 6 p. m.

PREVAILING WINTER WINDS

At Salt Lake City for forty years from United States Weather Bureau Records (Figures indicate miles per hour.) Values for hours ending at clock time stated.

Time	Direction	Miles Per Hour
1:00 a. m.	SE.	5
2:00 a. m.	SE.	5
3:00 a. m.	SE.	6
4:00 a. m.	SE.	6
5:00 a. m.	SE.	6
6:00 a. m.	SE.	6
7:00 a. m.	SE.	6
8:00 a. m.	SE.	6
9:00 a. m.	SE.	6
10:00 a. m.	SE.	6
11:00 a. m.	SE.	7
12:00 noon	S and SE.	7

Average relative humidity at 6:00 a. m. in winter, 75 per cent of saturation, or with pointing 28 deg. moisture by actual weight, 1.33 grains per cubic foot of air.

Note.—The fogs and smoke usually occur during the hours indicated above.

The following winter of 1905-6 was exceptionally foggy. During this period the temperature averaged 1.7° daily below the normal or average temperature; and out of the 90 winter days there were 36 days when more than a trace of snow lay on the ground, and another week or two when patches of snow were observed, to maintain high humidity conditions.

In January, 1913, more fogginess and smokiness occurred than in any other month during the past forty years, there being 18 gloomy days. During these January fogs the wind averaged from one to six miles per hour from southerly directions. It also is of interest to note that from the 9th to the 18th inclusive when only one light fog occurred, the total daily number of miles of wind blowing across Salt Lake City averaged 293; but during the continuous foggy, smoky weather from the 19th to the 31st inclusive, the average daily number of miles of wind was only 105, or only about one-third as much.

The total amount of moisture contained in the atmosphere during our winter mornings, with relative humidities of about seventy per cent and average temperatures around thirty degrees, is about 1.3 grains per cubic foot, by actual weight. Not all of it can be condensed on smoke and smelter dust particles, or absorbed by the hygroscopic sulphur dust or acids, in the free air conditions, yet, if only one-fourth of it appears as visible moisture (which is doubtless 0.3 grains, of new sulphuric acid would be produced for every cubic foot of air from the ground up to the average limit of the smoke and soot. This, it must be remembered, is the amount added to that already contained in the air, thus making the total amounts very great, if it is not regularly precipitated by rain storms, or driven out of the valley by windstorms.

If the hundreds of tons of sulphurous soot suspended in the air over Salt Lake City at any one time were perfectly dry it would cause but a relatively small percentage of the detriment that now occurs. Absolutely dry smoke particles of whatever size they may happen to be, would be very much more buoyant than moisture-coated particles, and would not only float higher and be more thinly distributed throughout the atmosphere and have less tendency to fall in sheets and clouds upon the city, but by reason of their floating higher, would find themselves in air whose movement is normally from five to twenty times as rapid as the movement of surface air. And thus would the dry dust-like soot be carried beyond the city limits before it fell to earth. Moreover, in a perfectly dry air, where no moisture could appear on the smoke particles by condensation, the lower strata of air would contain practically nothing but the coarser, heavier particles; the finer and more troublesome soot and dust occupying the greater altitudes, finding as nearly stable equilibrium high in the air as the heavier particles find in the lower, denser air.

And so far as the smoke particles re-

NUMBER OF FOGGY AND SMOKY DAYS IN SALT LAKE FOR 22 YEARS.

(On about half of these days the view was obscured entirely beyond 1,000 feet; on the remainder, the view was obscured beyond one-half mile; no record of the lesser amounts of smoke or fog.) (From U. S. Weather Bureau Records.)

Date	Jan.	Feb.	Mar.	Ap.	May	Jun.	July	Aug	Sep.	Oct	Nov.	Dec.	Year
1891	..	..	..	..	..	..	..	..	..	..	..	..	None
1892	4	4	..	..	..	..	..	..	..	..	..	..	8
1893	2	..	..	..	..	..	..	..	..	..	..	..	2
1894	..	..	..	..	..	..	..	..	..	..	..	..	None
1895	..	..	..	..	..	..	..	..	..	..	..	1	1
1896	3	..	..	..	..	..	..	..	..	..	..	..	3
1897	..	..	..	..	..	..	..	..	..	..	..	..	None
1898	..	..	..	..	..	..	..	..	..	..	1	..	1
1899	..	..	..	..	..	..	..	..	..	..	..	2	2
1900	6	..	..	..	..	..	..	..	..	..	..	..	6
1901	..	1	..	..	..	..	..	..	..	..	..	1	2
1902	8	..	..	..	..	..	..	..	..	..	..	..	8
1903	7	6	5	..	..	..	..	..	..	..	1	10	29
1904	3	..	..	..	..	..	..	1	..	1	..	1	6
1905	1	1	2	..	..	..	..	..	..	..	4	14	22
1906	11	15	4	..	..	..	..	..	..	..	7	3	40
1907	11	3	2	..	..	1	..	..	..	..	7	1	25
1908	6	1	2	..	..	..	..	..	..	5	2	3	19
1909	1	6	..	..	..	..	..	..	1	5	4	2	19
1910	5	1	..	..	..	..	..	3	..	..	4	6	19
1911	2	2	1	..	..	..	..	..	..	..	..	4	9
1912	3	2	1	..	..	..	..	..	..	1	2	16	25

main dry this natural distribution of the coarser and finer particles occurs, but unfortunately, with winter humidities in Salt Lake City of from 65 per cent to 85 per cent of saturation, probably no smoke particles, however small, descends very far towards the earth on its return journey before it is cooled to the temperature of the dew point, and annexes its full carrying capacity of moisture.

View looking southeast from Ensign Flat, north of the city, showing bank of fog and smoke at right. Taken at noon on a perfectly clear dry and very light northerly wind. City Creek canyon in foreground, Wasatch mountains in distance, Fort Douglas in foothills, left distance.

Instantly then, do we have the light-obstructing smoke particle of say, one three-thousands of an inch in diameter increase in size to one-thousandth of an inch in diameter; that is, rendering an atmosphere clogged with dry smoke and dust particles from the smelter smoke and elsewhere, about three times as opaque with the moisture, or fog particle added. Of course, in nature, this condition is usually limited to small streams of cold air, or to small regions of quiet air, the fog area growing gradually. In nature it is also true that one dust-moisture particle will unite with another, and those in turn with others, the tendency to coalesce being limited only by the amount of humidity available.

The condensations on the larger particles may not immediately increase their size three fold in low humidities, as it does the smaller ones, yet the increase will soon reach this dimension if there is sufficient humidity available. Therefore, in considering the actual sight-carrying quality of the air over the city, alone, with an air so dry that no cooling dust particle could reach the dew point and collect its moisture load, if we could see an object three blocks away, it is reasonable, in general, to calculate that in a moist air, with all particles collecting moisture, the same object would be obscured beyond one block, or just one-third as far.

Moreover, we have it from eminent meteorologists and engineers, that the unconsumed mineral oils in the fuel smoke forms an oil film around every fog or moisture particle which greatly delays evaporation, renders the fog more tenacious and much more durable than a plain, common country or seashore fog. The moist obscuration, now of triple density, is therefore become an object of far greater permanency and continuity of texture than the former mere mass of segregated, separated, unbonded smoke particles.

The sulphur dioxide gas, rendered so abundant in our atmosphere by the smelters, coming in contact with the moisture particles, instantly forms sulphuric acid, as we have previously pointed out. In low humidities, when there is a dearth of moisture, the new sulphuric acid is in condensed form; but during high humidities, with abundant moisture, the more dilute sulphuric acid naturally results, at first.

However, unless the relative humidity is very close to one hundred per cent, or actual saturation, it is improbable that the sulphuric acid poison is very much diluted. This is because of the great and unquenchable thirst the sulphuric acid and the sulphur dioxide has for water; and where the moisture is in sufficient quantity to render the atmospheric sulphuric acid somewhat dilute, the chemical tendency of the sulphur dioxide is to attach more of its own molecules to the water, or sulphuric acid particle if more are available, thus maintaining a very condensed, or strong grade of acid in the air. Our smelter-fed air seldom goes hungry for sulphur dioxide.

These deductions are made from the statements found in some of the newer and more thorough text books on chemistry showing that "about fifty volumes of sulphur dioxide are dissolved by one volume of water at 15 degrees."

View looking south (down Main street) from Ensign Flat, north of Salt Lake City; southern portion of city lost in dense "smoke" at sunrise; very faint southeasterly wind, causing the fog to creep slowly northwestward over the city. Thirty minutes after this picture was taken the entire city below Capitol hill was lost in the fog. Smoke from business district goes very high compared with residence smoke.

Therefore the significant fact is apparent that if one volume of water can annex as much as fifty volumes of SO_2 gas, making a sulphuric acid molecule for every molecule of water (obtaining the other oxygen molecule from the air) the air containing the water and dust and smoke particles as obstructions will be rendered at least two times as opaque, making objects visible at only one-half

the distance and obstructing one-half the former amount of sunshine, by the mere manufacture of the sulphuric acid; and thus the view is shortened to about one-sixth its original length in clear air.

Now we have seen how the moisture will be a millstone about the neck of every smoke particle, weighting them down into the ground layers of air, and binding them together in a continuous but conglomerate mass in our breathing air. Yet this imprisonment of filth that would otherwise float away or settle in a relatively harmless way, is the mere beginning of the trouble; we not only have the smoke-grime wafted against us and against our clothing and books, but we have it rubbed in, so to speak, for while loose, free, dry dust is difficult to confine on any surface, the moist dirt, or, fog-dust has a peculiar affinity for material objects and it very readily attaches its load to every surface, and, once attached it requires the services of an expert to induce it to loosen its clutches.

The moist, fog-filled dirt clings like paint to everything, from our draperies to our memories. The expert who removes the dirt, removes also a portion of the fabric in the laundry, the moist dirt is that tenacious; clothing, furnishings, tapestries and soforth wear out much quicker against a washing machine than against our backs and in use, and they get it about four times as often as they would without the moist smoke.

But the mere moisture alone is not the greatest problem by any means, for laundries and industrious housewives, with care, can safely chase away a great deal of dirt of even this kind; it is the depredations of the sulphuric acid that are irrepairable and unpreventable. A little atom of dust gathered a little atom of water as a cloak, and this molecule attracted a molecule of sulphur dioxide, and this sulphur trioxide attracted chemically an additional molecule of oxygen and pure poisonous, penetrating sulphuric acid was formed, and this sulphuric acid, carried about by the original dust carrier, or in many cases traveling alone (perhaps incognito to be transformed to sulphuric acid by moisture from the receiving surface), alights on every surface, seeking whom and what it may devour.

Mr. H. M. Wilson, an engineer in the United States Bureau of Mines, writing recently in the Iron Age Magazine, says that in addition to the mortality increases where the sulphurous content of the smoke is great, and in addition to the losses from dry goods of all kinds, library books and office records, from the mere dirt, "the vast amount of painting and renovation rendered necessary by the caustic action of the sulphuric acid in the smoke upon all paint, iron and brass work," is considerable; and Mr. Wilson was writing only of cities which have to contend with the sulphuric acid from the coal smoke, whereas we, in Salt Lake City, have from five to twenty times as much sulphurous matter in our air, as a rule, to blight and poison and devour.

If the air were so dry that the smoke particles in cooling would not, ever, reach the dew point, practically none of the disastrous results would occur; yet with humidities of about seventy per cent on winter mornings as a rule, and dew point temperatures of from 20 to 25 degrees, the moisture units on the cooling smoke particles are quite sure to occur to a more or less extent, and forthwith, the heavy charge of sulphur dioxide gas, always in the air, begins the coalescing, and the manufacture of sulphuric acid, the deadly poison, upon the dust particles. And as has been previously pointed out, some physicists have claimed that the sulphur dioxide will combine with the invisible vapor, not yet condensed, just as our garments will take up moisture from the invisible vapor on a moist day, thus forming the sulphuric acid independent of the fog unit.

But omitting this last theory, plausible as it is, we find the sulphur to be responsible for a very large per cent of the obscuration, and for a still greater per cent of the final destruction of property.

A great deal more washing of fabrics is needed, as well as more cleansing of all cleanable articles; and as the tiny bits of cotton or wool fibre from the fabric break off, and the garments, or bedding, or carpets, or upholstery, or drapery or tapestries begins to "wear out," we realize that the life of the article is mysteriously shortened by what appears to be the laundering or the unusually vigorous methods necessary for cleaning; or by fading or actual decaying, yet the terrible fact is ever before us: the goods is being partially eaten by the ever-present sulphuric acid!

The laundry rubbing, even in the dry cleaning processes on the more precious garments and fabrics, does produce much wearing, but it does not wear several threads off at the same place, resulting ultimately in a hole; nor does it cause a garment or a fabric to pull apart, or go in holes under very slight stress, after having been laid away apparently clean from the clothes line—but in reality splotched with sulphuric acid deposits.

Much evidence has been introduced in courts and elsewhere showing that the galvanized coating of wire fencing has not only been corroded and removed by sulphuric acid deposits from the atmosphere, but that the wires have been so seriously acid eaten that they have fallen apart. And if these things be true we cannot blame the salesman, shopkeeper, or even the laundry for the short life of a shirt-waist that has waved and beckoned from a clothesline to every passing particle of sulphuric acid on a smoky, foggy day; or for the short life of an expensive window curtain which has acted as a screen or filter for great quantities of sulphurous soot, in the air we are trying to introduce into our library or bedroom for ventilation purposes.

When the threads of the curtain "break," before it has been cleaned, it is not because it has rotted down in the

Looking southwest from Ensign Flat, north of City. A light northwest wind for one hour had not only swept the city perfectly clean but filled the entire south end of the valley with the "smoke," thus obstructing the view beyond Granite. Picture taken at noon. The northwest wind was obstructed by the Oquirrh mountains on the west side of the valley, permitting the smoke from the smelters and elsewhere to obscure the range, except at extreme north. The heavy smelter smoke hangs low, finding its level always below the mountain tops.

dirt, not by any means; the dirt has teeth (sulphuric acid) and they cut as keenly as a two-edged sword; it is more insidious than moths, and more certain to get in its destructive work wherever it alights, though in many cases the dirt alon ruins the article before the final action of the sulphuric acid.

Looking southwest by west from Granite Stake House, four miles south of city center, showing the pretty but poison-laden veil of smelter smoke from the Garfield plant draped along the Oquirrh mountains; the valley, almost entire, was perfectly clean in a good northwest wind, except as shown along the west side, where even a hard wind cannot entirely dislodge the smoke. The view shows about one-half the Oquirrh mountains from the north end.

Sinc sulphuric acid is quite heavy, compared to air, like most fluids in a finely divided state, the larger particles of it float naturally nearer earth, as do the larger dust particles; and since in fog strata there is almost no vertical component of air motion, these heavier particles of sulphuric acid flowing leisurely along horizontally with the fog, partially disguised usually, as a smoke particle with a "jag" on, are the specks of poison that come most frequently in contact with our property.

While disease and discomfort in the human body are about as elusive as anything imaginable that we have to deal with, physicians as a rule are frank to admit that there is some powerful poison in city smokes or fogs, some stating without reserve that the poison is the sulphuric acid, if its identity may be traced by its results.

It is said to cause an intense smarting of the eyes in some people upon emerging suddenly into a well-laden strata of sulphuric acid- carrying air; persons troubled with nasal catarrh complain that during "clammy" foggy weather, their mucous membranes often become intensely irritated and while this is often said to be the result of the sudden change in humidity, there appears good reason to believe that if the sulphuric acid particles in the air will eat galvanized wire fencing in two, the small amount of it coming in contact with the nose membranes might also make itself known there.

But we breathe down into our lungs and the poison passing the nose must finally reach the lungs, and of course gets in its work on every surface. Many folks complain of irritating coughs in foggy weather, and usually attribute it to the "dust" in the air, though these same persons do not cough when carrying coal, or cutting kindling, or autoing along dusty roads. The real trouble would seem to be in the irritating sulphuric acid.

Not all the smoke goes through the smelter stacks. This scene may be witnessed every few minutes at the Murray smelter.

Again to quote Mr. H. M. Wilson from the Iron Age magazine, "One of the principal ingredients of smoke is sulphuric acid, and every dweller in a smoke-laden community must each moment take into his lungs this powerful poison." He quotes eminent physicians of Europe and America as saying, "The death rate from all lung diseases is largely increased, and tuberculosis gets in its deadly work in half its usual time." Now if these terrible things are true in average cities (he was speaking of all large cities) how much more potent must be the sulphuric acid in such quantities as exist in Salt Lake City?

Must this become a city from which fresh air excursions will be made out into the uncontaminated mountain air to rest, refresh and rejuvenate child-lungs and eyes, and a city to be avoided by every person of whatever age who appears to be troubled by the smoke of other cities?

This same government official, Mr. Wilson, also quotes the city park commissioner of St. Louis as saying that his shade trees, both the evergreens and the hardwoods, were being suffocated at the rate of five per cent a year, saying that all the older trees would be gone within twenty years because of the dearth of sunshine and the caustic action of the sulphuric acid.

And it is a well known fact that outdoor flowers in Salt Lake City are not only often imperfect, but dwarfed because of the poisonous ingredients from the air; and the leaves of all trees are more or less seared by the sulphuric acid, especially in late summer, after several weeks of quiet fair weather, when the sulphuric acid is permitted to accumulate on the moist leaf and plant surfaces; thus it is manufactured upon the spot where its subsequent destruction takes place.

Of the many ways in which financial loss results from smoke, none would be so great without the sulphur. The obstruction of the sun's rays, causing the use of more artificial light, less efficiency of employees, and so forth, would be less because the sulphuric acid is an obstruction just as is any other particle. The great loss to library books, office records, and the like, would be far less if the grime did not contain the staining, discoloring and devouring sulphuric acid.

Mr. Wilson, quoting official figures,

shows the annual loss from smoke and resultant influences in Cleveland, Ohio, to be $12 per capita, and in Cincinnati, and Pittsburgh to be $20 per capita. The values for all large cities show an average of $17 loss for every man woman and child residing in cities. It will not be forgotten, however, that this is a calamity which very rarely befalls the small city or the country town.

Now it is manifestly too conservative to place Salt Lake City in the list as an average for smokiness in these latter days, and probably a percapita loss each year from smoke and sulphuric acid here would reach $25 or even $30 considering all results. However, to be as conservative as possible in our reckoning, let us assume the Salt Lake City loss to be no more than the amount shown in the "average" cities of the United States, or seventeen dollars per annum per capita.

At the close of January, 1913, an estimate of our population made by the Salt Lake Tribune from records of the public service corporations and others, was about 115,000 people. At seventeen dollars each the total annual loss is practically two million dollars.

With this fact in mind, not forgetting that we have placed it as low as possible, let us return to the table of smoky, foggy days. Twenty-five gloomy days occured in the first eleven years and 221 in the second eleven years. With an increase in the number of foggy days proportionate to the population and coal consumption increase of 70 per cent, we would, normally, have had 42 instead of 221 foggy days in the second eleven years, as previously pointed out. The excess of 179 foggy days, or sixteen and one-fourth per year, has plainly been the result of the smelter dust and sulphuric products.

Now it is well known that there is no smoke damage on bright clear days; that when smoke rises high and is blown rapidly and does not accumulate in quietude in any portion of the city, even when it is not consumed properly. That is, there is no measureable loss from smoke which is not forced groundward and held in masses by moisture, winds and other influences, against ourselves and our property, and with such denseness as to diminish the sunshine.

Therefore, we arrive at the significant and indisputable fact that our loss of two million dollars annually is very largely confined to the foggy, smoky days, and so far as properly placing the responsibility is concerned, we can assume with perfect fairness that the loss be divided into units presented by the foggy days, exclusively, as observed and recorded by the U. S. Weather Bureau.

The twenty dirty days per year (since 1902) entailing the loss of two million dollars, is $100,000 for each and every day on which a fog or a smoke were recorded in the government records. And we have seen that the smelters are solely responsible for sixteen and one-fourth of these days in each of the past eleven years, which gives a loss from the sulphurous spouting smelters alone of $1,625,000 each and every year, probably varying with the number of foggy days from one-half this value to twice this value.

The smelter fumes continue their depredations throughout the farming communities of the valley, being caused especially from the Murray plant, but partially, it is said, by the "muzzled" Midvale plant. And while the damage is probably less to crops and livestock than formerly when arsenic-producing ores were handled more abundantly; and while prompt settlement is usually made with the individual for most of the damage to crops and domestic animals, there is no compensation granted for the loss to the public for the valley shade trees; the trouble said to be caused by the sulphuric acid deposited on fruit which is sold in the local markets and is reported by some as being the probable cause of certain stomach and intestinal disorders; and, perhaps more important, the damage to wild fowl and game birds.

Fred W. Chambers, state fish and game commissioner, estimates that 5,000 000 wild ducks died in the marshes around Great Salt Lake during the past three years. A dozen or so of these fowls were taken to the pathological laboratory of the United States Bureau of Animal Industry, and under the direction of Dr. J. S. Buckley and Dr. J. H. Mohler, were carefully examined. Efforts were made to infect live animals, birds, and ducks with cultures from the dead ducks, but the "Disease" could not be reproduced artificially, and thus it was proven not to have been caused by a micro-organism and not to be transmissible. The irritation of the intestines, or the catarrhal condition, was then reported by Dr. Buckley (in a letter to Mr. Chambers, and another to Dr. M. R. Stewart of this city) to be "due to inflammation of the alimentary tract caused by sulphuric acid."

As pointed out by Dr. Stewart and Mr. Chambers, a great deal of sulphur trioide accumulates on the ground during the dry weather of summer, and much larger quantities of the heavier-than-air sulphur dioxide gas in the valley air, so that the first good rain of autum produces vast quantities of sulphuric acid, which attaches itself to every object and wisp of vegetation throughout the valley, and forms a coating over all quiet water surfaces. And thus the ducks are poisoned by millions.

Mr. Chambers explains that many folks would be glad to pay from 20 to 40 cents apiece for good ducks to eat, and they should therefore be worth from 10 to 20 cents each in the marshes if a bird in the hand is worth only two in the marsh; but at his most conservative value estimate of twelve and one-half cents as food to the state, we find the deadly toll of the smelters from our game bird losses alone in three years of $625,000 or $208,333 a year.

This sum combined with the public damage in Salt Lake City, alone, disregarding the unpaid-for damages elsewhere in the valley, makes an annual charge against the sulphurous gases and solids from the smelters of $1,833,333.

And with this annual load upon her, can a "Pompeii" be unearthed; or can a "Sodom" breathe again the fresh air of the mountains?

———o———

Mercury is but slightly acted upon by sulphuric or hydrochloric acids, but is readily soluble in nitric acid.

———o———

What has become of the flock of electrically-operated steam shovels which the papers several months ago said the Utah Copper company was going to install at its Bingham mines?

———o———

It was reported here about the tenth of the month that the Utah Copper mills handled 18,000 tons a day for the month of January and that the output of copper would be only about 50 per cent of what it ought to be from such tonnage But, what of it? Whose business is it, anyway?

———o———

According to the annual report of the Guggenheim Exploration Company, there has been no change in the amount of Utah Copper shares owned, which indicates that they could not sell and would not buy. The 405,504 comprising the Guggenheim holdings, according to the report, cost an average of only $22.64, so there is still a chance to break even in that stock—PROVIDING THE PUBLIC CAN EVER BE INDUCED to see its tremendous "INVESTMENT" advantages. Besides, it should not be forgotten, as repeatedly explained by this magazine, that the smelting contract under which the Guggenheims treat the Utah product provides an additional profit, above current charges for treatment, equal to about ¾c. a pound on the copper produced—"alle same" Federal Lead.

PERTINENT OBSERVATIONS ON UTAH COPPER COMPANY

By JAMES O. CLIFFORD.*

The mining properties of the Utah Copper Company consist of about 730 acres of patented mineral land in the Bingham mining district, considered to be one of the largest areas of low-grade copper ore mineralization in the world.

Prospecting and development in the district has been more persistently followed by the Utah company than by any other interests owning extensive groups of mining claims in the mineralized area above referred to; consequently, to date, that company, according to the management's reports, holds first place in point of available ore reserves. However, in view of the peculiar structural relations of the rock series, and the consequent effect upon limitation of the zones of downward sulphide enrichment, it is quite probable that other mines will be developed in the near future which, in point of tonnage and relatively high copper content thereof, may be quite equal to the properties of the Utah company.

Bingham Canyon is a district of comparatively rough topography. The central mountain wherein the principal mining properties of the Utah company are located is defined by two deep canyons known as Upper Bingham Canyon and Carr Fork, respectively. The former slopes to the north, the latter to the northeast, joining together at a point immediately below the Bingham & Garfield railway station house to form main Bingham Canyon, which continues northward for several miles. The approximate elevation of the mountain mentioned above is 1,000 feet above the canyon levels, the average slope of its side being thirty degress from the horizontal. It is upon this mountain that the Utah Copper Company confines its steam shovel operations.

The areas of secondary sulphide enrichment in the Bingham district invariably are confined to zones of intense brecciation, and it is along one of these zones, commonly termed the Quinn fissure, that the principal mining properties of the Utah company are located. This zone of brecciation has a width varying from 200 to 800 feet, with a general average width throughout its length of about 400 feet. Numerous minor fissures parallel it but they are of importance only insofar as they represent lines of enrichment of no especial magnitude. Several cross fissures cut the Quinn fissure area, but apparentely they are confined to the extreme northeastern limit of that zone; consequently they intersect at a point without the limits of the Utah company's ground.

The Quinn fissure, as it is called, has a traverse of northeast by southwest, cutting obliquently across the central mountain before mentioned and passing out of the mineralized area controlled by the Utah Copper Company. Its productive length within that company's property is probably 3,000 feet.

As state above the limit of secondary enrichment (to which result the ore bodies of the district are due) is confined to the zones of sulphide enrichment; therefore, the productive property of the Utah Copper Company is limited in point of its commercial orebodies to the extent of the Quinn fissure zone within its confines; allowance being made, however, for the minor parallel fissures, though they are of no especial importance.

The orebodies occur as low-grade disseminated copper deposits within the intensely brecciated area, the values decreasing outwardly from this limit into barren rock. The principal copper mineral is chalcocite occuring as concentrations along the minute fracture planes of the brecciated area, and as minute impregnations of the rock itself. The general average copper content of the Quinn fissure limit of brecciation is probably about 1.7 per cent per ton, though frequently lines of especial enrichment are encountered in which the copper content will reach 3 per cent and more. These orebodies are overlaid by a capping, particularly with reference to the Utah company's ground, ranging from eighty to 160 feet thick. This capping is in part leached material having no economic value, even though it contains in some instances 2 per cent copper as carbonate.

AS TO TONNAGE AND VALUES.

Prospecting and development of the Utah Copper Company's mines has been accomplished by underground work and churn-drill operations, resulting in the development of 214.61 acres of mineral ground to an average depth of 480 feet—according to the management's report of April 26, 1912. Within this area there is said to have been delimited an orebody containing 301,500,000 tons of ore, of which quantity 229,830,000 tons were fully developed, and 71,670,000 tons partially developed. Further, the report states that "the above mentioned tonnage of developed and partially developed ore includes about 26,790,000 tons of partially developed ore in the slopes of the steam shovel workings." It is quite apparent, therefore, that no line is drawn between leached material having no economic value, and ore. Certainly if this material in these steam shovel slopes has not been definitely determined to be ore or capping, and is to be classed as "partially" developed ore, the suggestion is in what manner did the management correctly determine its "fully" developed ore reserves to a depth of 480 feet beneath the surface?

However, the management's report as above stated, then segregates the various tonnages of developed ore according to their relative copper content, the figures therefore being as follows: 62,040,000 tons averaging 2.0 per cent copper; 92,130,000 tons averaging 1.6 per cent copper; 75,660,000 tons averaging 1.3 per cent copper, and 71,670,000 tons averaging 1.28 per cent copper. From these amounts the management calculated the general average copper content of the 301,500,000 tons of ore to have been 1.532 per cent, or, after allowing 0.032 per cent to cover losses in mining through the admixture of waste with ore, the resultant figure was placed at 1.5 per cent.

Although a very limited allowance has been made for reduction in average metal content through the mining of waste material with the ore, there is not contained in the statement any allowance whatsoever for the loss of ore in mining, which, at the least calculation, would be a very considerable tonnage. Evidently it is assumed that the entire 100 per cent of ore developed will be mined without any loss whatsoever.

In practice, however, the mining of ore, either by underground methods, or steam shovel operations as they are conducted at the Utah properties will result in the admixture of waste material with the commercial ore in the amount of not less than 10 per cent, thereby reducing

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the general average grade of material to be mined from 1.532 per cent copper per ton to 1.379 per cent. Therefore, it will be apparent that the general average copper content of the 301,500,000 tons developed (no deduction being made for loss of ore in mining) will be 27.58 pounds per ton in place of 30.63 pounds per ton based upon the higher figure wherein this contingency is not allowed for.

In this connection it will be noted that, assuming the correctness of the management's distribution of tonnages according to specific copper content, the general average of grade of the 229,830,000 tons is 1.609 per cent copper, and the additional "partially" developed ore, amounting to 71,670,000 tons, has an average content of only 0.640 per cent copper per ton—not by any means commercial ore in the Bingham section. It will be assumed in this instance that the 10 per cent reduction in average copper content of the ore will offset the loss of 10 per cent ore in mining. Were this not allowed in the above calculations the actual recoverable tonnage of commercial ore would be reduced from 301,500,000 to 271,500,000 tons, and if a further reduction of 26,790,000 tons be made to cover the "partially" developed ore in the steam shovel slopes (which consists of about equal parts of barren leached capping, and carbonate ore not readily amenable to treatment) the absolute tonnage available would then be 244,560,000 tons containing an average of 31.02 pounds copper per ton.

The development of large ore reserves by the Utah company seems to have been a matter of simple arithmetical calculation, and, assuming the actual occurrence of a well-defined body of copper ore containing a stated tonnage of material of commercial grade, it is not a difficult matter to add thereto a given tonnage of practically worthless material containing a negligible copper content, and thereby to increase the total number of pounds of copper so that, while the quality of the original copper ore fully developed will be reduced to percentage content by the addition of the practically barren material, the total tonnage computed on the basis of its average content of copper will return a greater number of pounds copper in the aggregate, and still be of commercial grade. This feature is best illustrated by what has been said in earlier paragraphs of this paper.

However, using the Utah management's figures, it will be noted that if 229,830,000 tons of 1.609 per cent copper ore contain 7,396,920,000 pounds of copper, and we add to that amount the 71,670,000 tons of 1.28 per cent copper ore, containing 1,834,752,000 pounds of copper, the following results are obtained: The tonnage has been increased 31,2 per cent with an attendant increase of 24.8 per cent in total number of pounds copper, occasioned by a decrease in average copper tenor of the ore of only 4.78 per cent. Similarly, we can assume that the 71,670,000 tons of material contains no copper, in which event the average corrected copper content of the 301,500,000 tons will be reduced but 22.3 per cent as compared to an increase of 31.2 per cent in tonnage.

The above outlined statement of a means by which tonnages are increased is but one of many, but will serve as an illustration of how ore reserves are determined by the Utah management. Dependent upon the grade and quantity of the best ore in the mine, almost any series of results can be obtained whereby any desired increased tonnaged of lower grade ore may be "developed." Either practically barren rock, or material of no commercial value may be made to appear as ore of definite grade, but the result of such practice is always reflected in some other phase of operations—for instance, in the concentration of the ores. That phase of the operations will be discussed further along.

MINING AND STRIPPING OPERATIONS.

According to the Utah Copper management's report of April 26, 1912, covering the year ended December 31, 1911, the average thickness of capping overlying the fully developed ore-bearing area of its mining properties is one hundred and five feet. Removal of this capping was commenced in the summer of 1906, and to January 1, 1912, 33.52 acres had been completely stripped, which, on the assumed basis of 1,400,000 tons of developed ore to the acre, was equivalent to the placing available for mining by steam shovels 46,928,000 tons of ore. Of that quantity of ore there had been mined to January 1, 1912, (according to the management's statement) 15,885,521 tons, leaving in excess of 31,000,000 tons available for future operations—several years supply for the mills.

Now, in this connection, it is pertinent to observe that during the five and one-half years of stripping operations the company has removed the equivalent of 26,235,373 tons of capping from 33.52 acres of mineral ground, of which quantity of capping 11,337,256 tons were removed during the year 1911. Therefore, assuming that future stripping operations will be conducted on the same scale as during the 1911 period (12.65 acres per annum) it will require approximately 14.31 years to remove only the capping directly overlying the orebody from the remaining 181.09 acres of developed ore which it has been the stated purpose to mine by steam shovels.

The interesting part of the stripping operations lies in the fact that, in order to strip the 33.52 acres hereinbefore referred to, it was necessary to remove an average of 233 feet of overburden throughout that area, nor were operations confined to the section most heavily capped, but to the more favored sections where the overburden was lightest. This question of stripping will, however, be more fully covered in a later paragraph.

Both surface and underground methods of mining are conducted by the company and, according to the management's report for the year ending December 31, 1911, 4,680,801 tons of ore were mined. Of this quantity 26 per cent (1,217,008 tons) was mined from underground workings, and the remainder, 3,463,793 tons, by steam shovels. In view of the available area stripped for steam shovel mining it does not appear reasonable to expect that the company would continue its underground work in view of the relatively higher (?) costs accruing therefrom. To continue, it is noted in the statement of mining costs, that the average cost of steam shovel mining for the year 1911, was 33.73 cents per ton, of which amount 9.12 cents was charged to cover the cost of prospecting (?) with churn drills and of stripping expense, leaving a net cost of 24.61 cents per ton of ore mined by steam shovels. Similarly the average cost of underground mining was 68.35 cents per ton, of which amount 15.66 cent per ton was charged to cover the cost of underground development. From these figures the management computes the average cost per ton of ore mined by both underground and surface methods at 31.98 cents, an amount in excess of the costs at the Ohio Copper Company's mines, where all ore mined is by underground methods, and the relative tonnage is but one-tenth that mined by the Utah company.

FAILURE OF STEAM SHOVELS.

Steam shovel mining at the Utah Copper mines is a failure insofar as its advantages over underground mining methods are concerned, and tacit acknowledgement through a continuance of underground operations and preparations to push the work more rapidly during the coming year. Though the company had stripped an area or 33.52 acres to January 1, 1912, which, according to reports by management, contains more than 31,000,000 tons of ore available for steam shovel mining, (equivalent to about six years supply for the mills) there seems

to be urgent need for underground mining of ores to the extent of twenty-five to thirty and more per cent of the total tonnage derived from the property and shipped to the concentrators. With the underground development under way at present the mine will be prepared to output more than thirty per cent of the total tonnage required, and it is said that later the underground development will be completed to care for the entire tonnage requirements of the mills.

It is impossible in the present paper to do more than outline briefly the conditions obtaining at Bingham with reference to steam shovel mining methods, and to point out a few reasons why that method is impracticable and apparently on the verge of abandonment. Later a more detailed article will be prepared and published.

Among the many conditions necessary to the practical application and economical operation of steam shovel mining are that the area of orebody to be stripped shall be of such nature that the quantity of material to be stripped shall bear at the maximum a ratio of not more than 1:1 to the quantity of ore to be removed. Any increase over this proportion of course correspondingly increases the cost, and it is desirable that the ratio of capping to ore be less. Other conditions are (a) that the slope of area to be stripped be of low degree consistent with the length, breadth and thickness of the ore deposit; (b), that the relative line of capping to ore be well defined, and further that the thickness of capping be not subjected to great variations over short intervals of space; (c) that the two dimensions of greatest extremity shall be the length and breadth, the width being of a minimum consistent with the others; (d) that ample dumping ground for waste material be available and close to the line of stripping, thereby reducing the length of haul; (e) that minimum railroad grades for the removal of waste and ore obtain; (f) that the bench series continue in descending scale, that is, maximum stripping at greatest elevation—ranging from the top to the bottom; (g) that bench slopes be maintained at a vertical height not exceeding in ordinary practice fifty feet. Numerous similar conditions might be outlined but they will not be considered now.

Conditions at the Bingham mines are not adapted to steam shovel mining methods. The orebody is confined to the limited brecciated zone hereinbefore mentioned known as the Quinn fissure, the total width of which at its extreme limit would not exceed 800 feet, or representing less than one-third of the face of the mountain at that point. The average slope of the mountainside is thirty degrees, covered with wash to the depth of from seventy-five to more than two hundred feet. The limited width of orebody is capped by overburden throughout its length the average thereof ranging from eighty to 160 feet. The average depth to which the orebody has been developed within the Quinn fissure zone is stated by the management to be 418 feet. The conditions, therefore, are in no way conformable to those necessary to the successful and economical operation of steam shovel mining.

Commencing its operation nearly seven years ago the Utah company began stripping the orebody at the base of the mountain, and gradually extending the bench series upward toward the crest. The result of this practice was that in view of performing greatest stripping at the base the relative angle of mountain slope was increased. Later a series of fifteen terraces of uniform average slope and height were run, completing a series of bench-work from the base to the top of the mountain. However, stripping was confined principally to the lower terrace so that in lieu of reducing the mountain slope it gradually was increased. Recently it has been found necessary for maximum stripping to be conducted on the top-most terraces to prevent a further increase in angle of slope, and incidently to permit operations on some of the lower benches which, heretofore, have been unable to withstand the pressure resulting from a too high slope of bench and have caved.

Steam shovel mining of ore is confined practically to one area of very limited extent and known as the "shovel pit" at the base of the mountain. This pit undercuts the first terrace, making its vertical distance, corresponding to the heavy angle of slope, in excess of 325 feet—which precludes any further operations therein until a reduction of this bench has been made. In view of this circumstance the area immediately adjoining the first terrace has been sunk to a depth of fifty feet below the average level of the old pit, mining being done therein on the order of open-pit methods. The limit of the open pit operations have, however, reached a maximum depth insofar as railway haulage of ores therefrom is concerned, to haul one 60-ton carload of ore from the limited area mentioned requiring from one to two locomotives. Consequently, if operations are to be continued in this limited open pit, it will be necessary to install hoisting works to care for the ore mined by steam shovels.

Excepting the steam shovel pit mentioned in the preceding paragraph only a very limited tonnage of ore is mined from the numerous terraces lying above that area, and it is reasonable to believe that, if the area stripped as hereinbefore mentioned is available for mining operations, the company would derive the greater tonnage from other sections where the expense of operation would be lower, and also, that underground mining operations would be discontinued.

REMOVAL OF "WASTE" CANNOT STOP.

However, in the matter of stripping the orebody it is pertinent to observe that regardless of the methods employed in future operations it always will be necessary to remove a tonnage of barren material from the mountainside, even after the surface of the orebody has been stripped of overburden. This results from two principal causes; the first that, due to the comparatively limited width of the orebody to the width of the mountain face current operations of ore removal will be attended by the removal of JUST TWICE AS MUCH BARREN MATERIAL; further, that in lieu of decreased cost of operations per ton handled, there will be a marked increase. While it is claimed by the management that when stripping of the orebody is completed there will be no necessary for shovel operations only in the absolute mining of ore, such statements are misleading, for the reason that, so long as the company continues surface mining with shovels the expenses of stripping operations always will bear a ratio approximating twice the cost of steam shovel mining of ore. Therefore, by reference to the last paragraph of this paper it will be noted that, if charges are made as they should be, a profit, legitimately earned, will not appear.

To briefly outline why it will be necessary to continue stripping operations after the orebody has been stripped across two dimensions, if steam shoveling methods are to continue, the following will serve:

First assume the general average dimensions of an orebody 400 feet in width by 3,000 feet in length, by 400 feet in depth cutting obliquely across a central elongated mass of barren material, approximately three miles in circumference at the base and attaining an average elevation of 1,000 feet above the surrounding country. Assume the general average mountain slope to range between thirty and forty degrees. Now consider that the average thickness of barren material capping the orebody is 100 feet. Beginning at the base and continuing to the top of the mountain a number of terraces affording a grade consistent with the length of swith-back used are constructed. Stripping of the overburden is begun and the orebody uncovered across two dimensions, during which op-

eration it has been necessary to remove just twice as much (at the lowest calculation) barren material from the areas immediately adjoining the orebody as were contained in the original capping of the orebody. Continue operations along the third dimension (depth) and then determine if it will be possible to eliminate a continuance of stripping of material from both sides of the orebody, without occasioning impossible bench slopes and correspondingly heavy railroad grades. Also, consider that as reduction of the mountain is accomplished the length of lead (haul) correspondingly increases. From this illustration anyone can gain a favorable idea of the situation at Bingham, and the impossibility of dispensing with stripping operations. It makes no difference whether operations are conducted along the longitudinal axis of the orebody or its transverse section, the result will be the same. It is quite apparent, therefore, that the extracting of the limited orebody by steam shovel methods is tantamount to moving a great portion of the mountain, and from the point of view of economic mining, is absurd.

In view of the present conditions of the mountain upon which steam shovel mining has been performed it would present a difficult engineering problem to determine a system of caving the underground orebody without serious losses of ore in the upper area which have partially been stripped. Steam shovel mining, therefore, will have to be continued for a while at least.

A very desirable means of mining the orebody (which I understand is under advisement by the Utah Copper management) is the acquisition of the Mascotte tunnel which serves the Ohio Copper Company. Either this tunnel, or one similar to it would solve the problem of mining, and afford a cost per ton of ore mined of about thirty cents. The orebody then could be mined either by a modified caving system, or a series of mill holes, and would be productive of a saving of several millions of dollars annually.

MILLING OPERATIONS.

The Magna and Arthur plants of the Utah Copper Company are at Garfield about eighteen miles northward from the Bingham mines. The ore is hauled thereto via the Rio Grande Western railway and the Bingham & Garfield railway, the latter owned by the Utah company.

The combined normal capacity of the Magna and Arthur concentrators is 21,000 tons daily, and in flow-sheet they are of the same type as the Ray Con. concentrator at Hayden, Arizona.

As stated by the management in the report hereinbefore referred to the total tonnage of ore treated at both plants during the year 1911, was 4,680,801 tons. The average content of the ore was 1.51 per cent copper, from which there was a stated recovery of 21.03 pounds per ton—equivalent to an extraction of 69.53 per cent. There is some doubt about the correctness of the above stated figures, inasmuch as the management in the conduct of its business always "juggles" the reports to meet a favorable tonnage treatment, percentage extraction, and so forth, so that internal operations can be covered up.

Not at any of the plants operated under the same management are conditions maintained on a normal unit basis. There is always an apparent tendency to sacrifice efficiency by putting through a maximum tonnage, regardless of the copper content of the ore, and circumstances at the Utah Copper mines demand that maximum tonnage be treated if any copper is at all to be recovered by the concentrators. Consequently, it is safe to assume that the general average copper content of the ores put through the mills during 1911, did not exceed 31.02 pounds of copper per ton, and that the mills averaged throughout an overload of at least twenty-three per cent. Under the circumstances the average percentage copper recovery did not exceed 52.56 per cent. Of course the public receives figures on the operation of the concentrators, but such information as might be given them is of no value, only insofar as it serves to occlude the shortcomings of the management.

An instance of this practice is presented in the following: On the record sheet kept in the offices of the company I have in mind the daily operations of the mills are entered in ink. This report outlines the tonnage of ore treated; average content of mine-run ore; average tailing; ratio of concentration; copper content of concentrate produced; cost of operation, and such additional data as required in that line of operating. However, incidentally, and on the same report there is kept a series of figures in pencil as a means of comparison. One set of figures represents what is termed the ACTUAL operations, the other what is termed the APPARENT operations. The statement of ACTUAL operations represents, as the term implies, the actual results obtained, and the statement of APPARENT operations represents what they "ought to be." The stockholders and public are given the latter set of figures for perusal.

The Utah management states that the average cost of milling ore during 1911 was 41.68 cents per ton, but this figure is based upon the treatment of an increased tonnage of 4,680,801 tons as hereinbefore outlined, and therefore is not representative of the actual cost, which is several cents higher. This results from the fact that when the efficiency of a mill is sacrificed to tonnage treatment it does not make any difference how much material is run through in excess of its normal rated capacity, the cost of operating does not increase above a definite limit—which is its maximum after it has been "tuned up."

PRODUCTION COST OF COPPER.

The most important feature in connection with the operations of any mining or metallurgical enterprise is the comparative cost of production. Therefore, in the following paragraphs attention will be given to the production cost of copper by the Utah Copper Company. The quantities and amounts used in the estimates herewith given are those contained in the company's annual report for 1911, and while numerous corrections could be made with reference to tonnage mined, and so forth, it is best, perhaps, to use the management's figures, as readers then can make the necessary corrections to meet conditions as they have been pointed out.

The production cost of copper for the year 1911 was 7.8655 cents after applying credit of 1.07 cents for gold and silver recovered. A net recovery of 93,514,419 pounds of copper is reported.

By referring to previous paragraphs it will be found that the absolute expense of production costs (wherein no allowance is made for any deferred charges whatsoever) results as follows:

Mining expense 4,680,801 ton at 31.98c	$ 1,497,020.16
Stripping ore, 11,337,256 tons at 33.73c	3,824,056.45
Freight on ore	1,440,748.55
Milling cost	1,950,988.83
Smelting, refining and freight	2,717,592.85
Selling commission	118,261.64
Improvements, equipment mines and mills	1,215,120.76
Total	$12,763,789.24
Copper sold, 93,514,419 lbs. at 12.6463c.	$11,826,164.58
Gold sold, 40,202,916 ozs. at $20.00	804,058.32
Silver sold, 366,906.960 ozs. at 53.3c	195,564.36
Miscellaneous	165.56
Total	$12,825,952.82

From the above it will be noted that the net operating profit, (which should include also an item of $30,966.00 for interest paid) is $62,163.58 for the year,

with which amount dividends amounting to $4,703,858.42 were paid during the year, occasioning a deficit of $4,640,858.42. If, in addition to the interest charges of $30,966 mentioned above, we should add a difference of $35,594.65 which appears as the excess charged to mining according to the company's report (the amount given being in the annual report as $1,529,275.62 in place of the above stated amount—the correct amount, however, should have been $1,493,680.97, or at the rate of 31.91 cents per ton in place of 31.98) the aggregate would have been more than enough to have completely cleared the profit of $62,163.58 as above stated, and occasioned a direct deficit of $4,497.07 for the year. This, then, exclusive of income from other investments (such as Neveda Con., and so forth) is representative of operations at the Utah Copper Company's properties. The production cost of copper, therefore, is 13.65 cents per pound, and, after deducting 1.07 cents for gold and silver credits, the cost appears as net 12.58 cents per pound.

Since the commencement of steam shovel operations at Bingham it has been necessary for the Utah company to carry a tremendous floating debt to care for the stripping expense, and while the item appears in reports to stockholders as a deferred charge for which a sinking fund has been established to cover, at the same time it is noticeable in recent reports that the tendency is to charge the item to capital account through the medium of the profit and loss statement, wherein it is not so conspicuous and can readily be cleared from the books at any time through the method of accounting employed by the company.

In the preceding paragraph the direct charges of stripping operations are included in the production cost of the copper as it should be, with the exceptions hereinbefore noted, and then there were many miscellaneous items eliminated in consideration of the acceptance of the more important charges, which, had they been used, would have tended to increase the production cost a few points. The production cost of copper for 1911 is representative of about the average cost during the past few years, and it is plainly evident that, only by charging off stripping expense, cost of improvements and other such important current expenses that the company has, together with its income from the Nevada Consolidated Copper Company and similar investments, has it been able to create a dividend It is quite evident that a dividend has not been earned, but created and the natural suggestion is that operations are being conducted entirely upon borrowed capital.

The mining property of the company is valuable, but not in the same degree as the management states. Like other great properties its contained orebodies are limited in extent and value, and intensive development with the changes necessary in mining methods doubtless would permit its operation to a substantial profit—provided it were not encumbered by the heavy indebtedness which apparently exists, from what has been said above, and free from the management of stock market mainipulators. Only when the necessary changes are made with reference to mining, milling and operating methods, will the property become a "self-contained manufacturing proposition"—which at present it is not.

EXTRACTING GOLD FROM GRAVEL DEPOSITS (IV)

By AL H. MARTIN.

The mining of gravel deposits overlain with barren overburden present difficulties that appear the more complex the more familiar the engineer becomes with conditions. It not infrequently happens that the surrounding country is on the same level as the overburden, and the varying gold values and particular character of the bedrock renders impracticable the employment of dredgers, elevators or other comparatively favorable methods. It is necessary to either employ cars or wagons to transport the overburden from the deposit (generally economically impossible because of the excessive costs) or stack the debris in banks on either side of the channel and still keep the pay gravel clear and easily accessible. Ordinarily the overburden, or spoil, consists of sand, clay, gravel and boulders ranging in depth from ten to fifteen feet. The problem is not so much the disposition of the spoil, as the clearing of the pay gravel and its constant freedom from the overlying barren ground. The steam shovel, drag-line excavator and other methods suggest themselves, but each has its particular field, with its adoption based upon the natural conditions of the deposit and the work to be done.

GRAVEL-DIGGING DEVICES.

The steam shovel easily commands stellar attention as a particularly efficient digging machine, but is handicapped by its short excavating radius, and even more limited stacking facility. For shallow work the steam shovel has proven markedly effective, but when deeper stripping is carried on the inability of the shovels to stack their burdens advantageously becomes apparent. Unless the sides of the cut are fairly steep, the shovels are unable to stack the debris firmly, sloping sides resulting in unsatisfactory work and frequent delays. With shallow deposits, however, the steam shovel has been proven an efficient means for divesting the pay-gravel of its barren capping.

The machine generally employed is provided with 65-foot booms and dippers of 3½ feet capacity, with a digging and stacking capacity of 120 to 200 cubic yards per hour. The lower frame is fashioned of steel, mounted on four swivel trucks with four double-flange wheels to a truck. For rotation of the machine a rail circle and steel circular rack are installed at the upper portion of the frame. A hydraulic equalizing device is provided to secure a uniform weight adjustment, permitting the shovel to be moved ahead and operated on uneven tracks without twisting the frame or subjecting it to unnecessary strain. The device also keeps the turntable on a constant level, facilitating its revolutions with a minimum usage of power and lessened strain. Each machine is self-propelling, with the dippers capable of excavating excessively hard ground.

However, refractory material naturally results in less capacity per hour, and it has been found well in such cases to have two or three men in advance of the machines to drill and blast the refractory material. The short-boom shovel has many advantages over the long-boom type and is favored by many engineers for stripping where the capping is not too deep. But no matter what type of machine is used, the steam-shovel operator is constantly hedged about with limitations. When the ground is soft, with decided slopes, even a long-boom machine is unable to stack the spoil to advantage, and the constantly sliding ground makes wide cutting exceptionally difficult.

To reinforce the steam-shovel, several appliances have been devised, including the locomotive crane and portable incline-tipple. The locomotive crane travels on rails along the beam as the shovel makes its cut and elevates and stacks the debris as it is excavated. Three to

five loads of a dipper are deposited in a receiving box, which is raised by the crane and the contents deposited on the bank. While the crane is elevating and discharging one box, the shovel is loading another. Fairly good time is thus achieved, but some strong objections to this method have been aroused by the breaking of boxes, additional labor required, and difficulty experienced in effecting rapid detachment from the empty box and connection with the loaded receptacle. The incline-tipple has proven its ability to handle the material excavated by the shovel and has many advocates, although the construction cost is so high that only under favorable circumstances is its employment considered justified. The machine operates just back of the shovel, and the cars are hoisted by a double-winding engine with each drum operating independently. This permits practically continuous action.

While the steam-shovel has proven highly efficient for the mining of ore previously broken by blasting, it is not generally favored by engineers for placer mining save in unusual cases. It is being employed to some extent, but the drawbacks affecting its usage, as herein indicated, militates against popular approval. The machine lacks that mobility essential in placer mining, and the necessity of using auxiliary, and usually expensive, means for handling the material excavated, renders its employment impracticable in the great majority of instances.

THE DRAG-LINE EXCAVATOR.

The drag-line excavator is a machine that has elicited much favorable comment from operators in Siberia, America and other countries, where the mining of gravel deposits under unfavorable conditions has received particular attention. The type of machine largely favored is of the rail-circle, with the lower frame mounted on trucks, and sixty to 100-foot booms. The excavator operates on a rail track and digs to a depth of a few inches to thirty feet, and commands a radius of 100 feet from the center of the tracks. The hoisting cable runs over a sheave at the outer end of the steel boom and connects with the buckets, usually 1½ to 2 cubic yards capacity. This cable is actuated by the first drum of a double-winding engine. Over the second drum stretches the pulling cable, attached to the chain-bale of the bucket and a short compensating line fastened to the forehood of the bucket. This enables the bucket to be suspended in any position and naturally increases the mobility of the device. The bucket is usually provided with manganese steel teeth and bites into the most difficult capping or gravel with easy facility. The bucket is dropped to the fresh ground or into a cut and dragged toward the machine by the pulling cable, filling as it drags. When full it is hoisted and swung by the swinging engine, through ropes or geared swing, over the desired point on the bank where it is discharged by loosening the strain on the drag line. By this means the overburden is easily stacked to a height of twenty feet at any point within the radius commanded by the machine.

The machine works backwards and with the working out of one section of a cut, the track couplings are removed by two track-layers, the machine raises a section of the track from in front and replaces it in its rear, and the new line is connected. The operator again lowers the bucket to the cut and operations are resumed. While the bucket can only be successfully discharged from a position vertically below the head sheave, it is capable of excavating to a distance of fifteen to twenty feet to each side from the vertical and to a length of twenty feet in front of the excavator. The drag-line excavator possesses manifold advantages over other mechanical digging devices, and its mobility makes it particularly efficient under most conditions. At the Kolclan mines, East Siberia, machines of this type are excavating gravel to a depth of twenty-seven feet and handling sixty cubic yards per hour. Under favorable conditions the working costs average around nine cents per cubic yard.

SIBERIAN PRACTICE.

In Siberian practice machines with long booms, approximately 100 feet, are preferred for stripping, while sixty-foot boom excavators are deemed desirable for actual gravel mining. The gravel thus excavated is discharged into Russian floating washing plants equipped with log washers, screens, gold-saving tables and tailing stackers, or diverted into ordinary sluices. As an excavator the drag-line bucket is hardly as efficient as a steam-shovel, but as a combination digger and stacker it has won commanding recognition as an efficient and economical machine. Two types of buckets are used, those having swinging chains or fixed bales. The bucket with the stationary bale is a splendid excavator of hard ground, and is more readily controlled and guided than the chain type, but the latter have proven their merit in digging soft or previously loosened material. The initial cost of an excavator is not as large as that of a steam shovel, while the greater facility with which it may be operated and transported are salient points in its favor.

The great advantage of the drag-line excavator over the steam-shovel is its ability to stack the material under conditions that require auxiliary equipment when the steam shovel method is employed, and this is a factor that means the employment of the drag-line machine in practically all placer mining enterprises where mechanical excavators are required. Two men, an engineer and a firemen, are required to operate the drag-line excavator, with three laborers employed to attend to the tracks. Thus the labor cost is low. In operating the larger type of the steam-shovel, two to three men are required on the machines, and four to attend to the tracks and assist in moving the shovel ahead. After years of experience with excavators and steam shovels operators have generally pronounced the former the most economically operated, save in cases where the shovel has been able to stack its own spoil. There are circumstances when the excavator can hardly be employed to advantage, as in the case of ground too difficult to dig, but the device is commanding increasing attention from operators in all sections of the world.

An excavator that has attracted interest in Germany and Russia for extraction of gravel at low costs is based on the dredging principle. The digging machinery consists of a bucket-line and dredge buckets. Instead of being discharged into hoppers, however, the gravel is hoisted over a tipple and dumped onto a belt-conveyor delivering to the tailings bank. The material is dug dry, and the machine has proven a success in many ways, but it is questionable whether such an installation would prove satisfactory in the mining of the coarse gravel generally encountered in most placer regions.

Besides the machines herein described for the winning of gold-bearing gravels from refractory deposits, numerous other contrivances have been evolved by ingenious inventors, but the devices have found little popularity with the matter-of-fact engineer. It is only when the dredging, hydraulic, elevator or other favored methods of mining gravel is proscribed by unsatisfactory conditions that the engineer turns to the mechanical excavator, and in this field the drag-line excavator has met with greatest favor, save in the isolated instances where the employment of the steam shovel has naturally met the requirements.

NOVAL COMBINATION SCHEMES.

A machine constructed along somewhat novel lines, but giving excellent satisfaction under rigorous exactments, is being operated in the Ruisseau des Meules district, in the province of Quebec, Canada. It consists of a steel elevator operating on rails, with the excavating equipment the digging section of an elevator dredge. The buckets are close-connected, with a capacity of 3½ cubic feet each and excavate to a depth of thirty-five feet. The elevator is mounted

on four trucks, each truck provided with two wheels, and the buckets discharge into a riffled steel sluice. Two hydraulic giants wash the gravel down to the elevator pit from whence the dredge buckets gather the material and delivers to the sluices. The wheeled trucks operating on rails spaced twenty feet apart enables the position of the machine to be changed whenever necessity demands, and the length of the steel sluice is augmented by sections of wooden flume from time to time. The waste material is sluiced away as in ordinary hydraulic mining. The process is a combination of the elevator, hydraulic and dredging methods and has proven markedly effective in handling a deposit that presented considerable difficulty because of unfavorable topographical conditions. Limited water supply, together with the slight grade of bedrock compelled the employment of the elevator method, and the application of the dredging principle for the excavation of the gravel washed into the elevator pit by the giants proved exceptionally satisfactory. The plant has a capacity of 180 cubic yards per hour. Electricity is used for power.

A combination hydraulic-dredger-mechanical-stacker method of handling gravel has been installed by the Tarr Mining Co. at its placers near Smartsville, California. The mines were formerly worked by the hydraulic method but were forced to close by the Anti-Debris Association, because of tailings deposited in navigable streams. In designing the plant it was imperative that it be constructed to operate within the stringent regulations affecting placer mining in California, and its building embodies several engineering features of particular interest. The gravel is hydraulicked by monitors to a sump located directly in front of the dredge building. This is a stationary structure, solidly constructed of concrete and sheet iron, with the excavating apparatus a steel dredge digging ladder of the regular girder type. The ladder carries fifty-two seven-cubic foot buckets. The latter excavate the gravel washed down by the monitors as in ordinary dredge mining and elevates to a trommel having dimensions of six by forty-five feet, with the screen containing half-inch holes.

From this the undersize passes direct to the gold-saving tables, provided with Hungarian riffles and having an approximate gold-collecting area of 4000 square feet. The fine materials passing from the tables flow into a bedrock tunnel about 2600 feet long which delivers to the concentrating plant. This is equipped with Overstrom tables, and was designed to save the black sands in addition to any gold and platinum that may have escaped the gold-saving tables. Before the product is fed to the concentrators it passes through revolving screens which permit only the fine materials to be concentrated while the coarser feed is diverted to the settling ponds.

The oversize from the trommel commands a belt-conveyor system, about 570 feet long and constructed in two sections. This delivers the tailings to two Bleichert tramways, which distribute to best advantage over the extensive dumping ground. The coarse material passing the gold-saving tables, and prevented by the revolving screens from joining the feed to the Overstrom machines, flows to the settling pond composed of a concrete dam. By this method the escape of even minute quantities of foreign matter to navigable watercourses is effectively prevented. The digging ladder is actuated by a 100 horse-power electric motor, while each of the two sections of the conveyor receive power from 50-horse-power machines. A 30-horse-power motor drives the revolving screens.

The plant has not been sufficiently operated to demonstrate its real merit, owing to friction among the stockholders which has constantly impeded activities practically ever since the completion of the works, but the short runs made indicate the methods can be profitably applied. In designing this plant the engineers were confronted with conditions demanding originality and recourse. Dredging was impracticable, because of the structure of the deposit and other unfavorable natural circumstances, while hydraulicking was proscribed by the laws of the State. Mechanical excavators were given consideration, but the method eventually determined on appears to have many recommendations in this particular application.

AVOID FAILURE BY STUDY.

When the question of installing equipment on a placer property is attentively examined, it is apparent that every engineer must be influenced by the particular condition he is called upon to control. A device that would be eminently adaptable to some districts would only spell failure if applied under diametrical conditions. The best type of excavator for any special work depends largely on its ability to handle the maximum amount of material at lowest economical costs, together with its facility for removing and stacking the spoil. The first cost of an installation is not always the paramount consideration—its adaptability for the particular work outlined is the prime factor. Frequently a combination of methods means success where it would be practically impossible to achieve best results with any one machine. Examples of successful installations of both types are sufficiently numerous to guide the engineer to the selection of the best method for his specific purpose.

But, not only is the type of machine and general structure of the deposit to be considered. In every important mining district the lack of even rudimentary knowledge of his subject by a so-called mining expert is silently but eloquently testified to by the rusting plants that could never have been anything but failures. Thus, in the upper valley of the Grand river, Colorado, a number of costly installations have been humiliating failures largely because the builders learned not how to prospect their holdings before installing equipment, and also because persistent attempts were made to recover the gold by amalgamation, when even cursory examinations would have shown that much of the gold was coated and would not amalgamate. And yet, despite consistent failures, subsequent installations continued to be made along the same old lines. Early mistakes in a new district are to be pardoned, but when the errors are continued and wholly because of the ignorance or carelessness of the psuedo-engineer, the strongest condemnation is deserved. In still other fields companies have experienced ignominious defeats because no provision was made for an adequate water supply, or because the type of installation was manifestly unsuited for the work it was intended to accomplish.

There is an immense difference in handling coarse and fine gold, yet many an oldtime coarse-gold miner attempts to recover the fine values by the same methods that prove so efficacious in the recovery of the coarser product. And when he fails to obtain the anticipated results the usual procedure is to damn the whole district, whereas the application of rational means would have frequently made the proposition a profitable one. Fine gold readily escapes the mediums provided for the recovery of the coarse product, and it is only by realizing this and using machines adapted for the particular treatment of the fines, that the engineer can hope to gain success when confronted by such instances. And unless he possesses the requisite knowledge of the district, character of the gold and nature of the deposit, no engineer can safely decide upon the character of the installation best fitted for the accomplishment of the work in hand.

It simply gives a fellow the "shivers" to think of the anguish that will be experienced by the holders of Utah Copper, Ray, Chino and Butte & Superior if the public holds aloof much longer.

CHINO COMING HOME TO ROOST

We find the following in the Boston News Bureau of the 17th under the caption, "Paris Selling Chino—Garbling the Facts:"

> Paris has been selling Chino Copper Company shares, of which a large block was placed in that city over a year ago. This selling may be attributed to absolute ignorance in that city of true conditions regarding the company's affairs.
>
> A Paris cable to the New York Times weekly financial publication—The Annalist—last Monday read as follows:
>
> "The porphyry copper mine shares have been more affected and are weak, but rumors that the Chino Copper Company will discontinue its dividends are discredited; however, a reduction of the rate is expected."
>
> The Annalist cable editor was apparently no better informed than his Paris correspondent, for in his resume of the entire foreign correspondence service for the week then ended, he called attention to the same alleged condition.
>
> Chino directors have yet to place their shares in the dividend ranks. With the maintenance of 17¾-cent copper, a $4 dividend basis would doubtless have been assured. What action the board will take when it meets late this month is problematical.

Pursuing the logic of the foregoing, which is peculiar to the string of subsidized mining and market reporters on "Managing Editor" Jackling's staff, had the price of copper metal advanced to 35½c. a pound, the dividends upon Chino stock could easily, no doubt, be maintained at double the rate mentioned or $8 per share. And if the whole of the mining costs were charged to the deferred, so-called stripping account, instead of only four-fifths of such costs, as at present, the dividend rate could easily have been advanced several points higher and the cost per pound of producing copper made to appear much below its present premier low-cost rate.

On the other hand, if the price of metal should fall back to 12c. a pound and if the management of the Chino Copper Company should charge to production all of its operating costs—as is customary with other people in such cases, and should report the large volume of high-grade ore which now goes direct to the smelter and is counted in to swell the volume and value of concentrates—the loss on the mining and treatment of ores passed through the concentrator would greatly exceed the losses suffered by the Utah Copper Company, as shown by its last quarterly report, which was nearly 3c. a pound.

Evidently our French brothers have discovered some of the tricks of this precious bunch of fakers.

Evidemment nos freres francais ont decouvert quelquesunes des ruses de cette prescieuse foule de faquirs. Vive le "horse-sense" francais; a bas Lawsonian humbugs!

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Will someone please tell us why it is [illegible] the Butte and Superior COPPER Company?

MORE "SMOKE" COMMENT

What has become of the Herald-Republican's "campaign" for an abatement of the "smoke nuisance?" And why has the fire chief subsided? He was quoted in December as promising a quick clean-up "as soon as we get a new police judge, on the first of the year." The City Commission and the Commercial Club—and the members of the Legislature—all ought to be hustling for an abatement of the nuisance. What is the matter?

Did not Mr. Alter, in the last issue of Mines and Methods and two of the daily papers, present unimpeachable evidence respecting the REAL cause of all the trouble? And, did he not clearly define a remedy that would be adequate and permanent?

On December 15th last the Salt Lake Herald-Republican loudly proclaimed: "Every citizen of Salt Lake is disgusted with present conditions and the Commission will find a healthy public sentiment behind whatever it may do to enforce the law and accomplish reform."

Now, if the City Commission, or the Commercial Club, or the fire chief, or any civic organization finds, as a result of the facts involved in the problem—as made plain by this magazine—that state legislation is necessary to wipe out the evil and clean up this town, why is not the aid of the Legislature, now in session, sought?

If it is felt that the showing and evidence presented by Mines and Methods in the last two issues is lacking in point or emphasis, let us suggest an unbiased perusal of the additional evidence presented by Mr. Alter, who is one of the Government's meterological experts here, in this issue.

Mines and Methods has been and still is spending money and doing its full share to show the people here what the real trouble is and point the only way to relief. Upon the showing made is there any reason why our county, city and state officials should delay in providing a means of applying the remedy?

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The Hardinge Conical Mill Co. of New York has received, among other orders, orders for two 8-foot Hardinge Patent Conical Pebble Mills from the Butte & Superior Copper Co. of Montana, and for three mills of the same size from the Commonwealth Mining and Milling Co. of Arizona.—Trade Note in Mining Science.

From which the deduction is drawn that these "great engineers" of the Utah Copper combine are really beginning to tire of making apologies for their Janneyized Chilian mills and are seeking something practical—something that will at least partially arrest "the overflow of mineral" in the tailings.

A common custom in Mexico and the Latin Americas is that of placing placards at mine entrances bearing the supplication: "Dios nos Guie"—translated, "God Guide Us." A sign like that placed at the entrance to the Utah Copper mines would be most applicable if the word "Guide" was changed to "Help."

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Isaac Guggenheim of New York, who is in Pasadena, says: "Opening of Panama canal will do much for this coast. It will do wonders for South America. I will invest in Chile. The assaults on capital which have been common since the day Theodore Roosevelt stepped into office make capital timid. Moneyed men will not invest within our jurisdiction, but will seek investment elsewhere." Isaac seems to be quite peeved.

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"Vice-president and Managing Editor Jackling of the Alaska Gold Mines Company" has been kept quite busy during the past several weeks repairing holes that have been shot into the barricades protecting the operating methods at Utah Copper, Ray and Chino. But, judging from the conflicting statements of various members of his publicity staff with those of his own, the "recoverable values" in the declarations made and excuses offered will prove negligible—they will escape with the "overflow of copper in the tailings," for Mr. Jackling has said: "We only give the stockholders such information as they are able to understand and digest."

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Several weeks ago, while gathering data for articles on the Ray Consolidated, Chino and Miami properties for Mines and Methods, James O. Clifford, the well known mining and metallurgical engineer of El Paso, stumbled on to the Utah Copper Company's annual report for the year 1911. Toying with the figures and statements it contained disclosures were unfolded that prompted him to come to Utah and make some observations for himself. He was profoundly impressed with what he saw and heard during his trips to Bingham and, while he found it impossible to cover the subject in such detail as he would have preferred to do before leaving again, he turned in an article—appearing elsewhere in this issue—which, while couched in modest, impartial terms, displays so much of the REAL condition of affairs affecting the company's methods, that readers will gather valuable information through a careful reading of it. His analysis of the company's 1911 report will be found of value in arriving at a fair estimate of the statements which the company will prepare and present in its forthcoming report for 1912.

THE SULPHURIC ACID INDUSTRY

By UTLEY WEDGE.*

To arrive at a broad understanding of the sulphuric acid industry in the United States, it is necessary to consider it in its relation to the great industries which require the production of sulphuric acid.

The greatest of these lines of manufacture which require sulphuric acid, are as follows, and opposite each is noted an approximation of the quantity of sulphuric acid consumed in that industry. Figures given are in terms of tons of 50 deg. Be sulphuric acide per annum:

	Tons
Manufacture of fertilizer	2,400,00
Refining in petroleum products	300,000
Used in iron and steel and coke industry	200,000
Manufacture of nitrocllelulose, nitro-glycerine, celluloid, etc.	150,000
Manufacture of aluminum sulphate and the different alums, sulphates of magnesium and similar salts, carbon dioxide and hydrogen, sulphide gas, aniline and other organic dyes and colors, hydrochloric, nitric, hydrofluoric, chromic boracic, acetic, picric and other acids, either, glucose, blue vitrol, zinc sulphates, and in the metallurgy of copper, gold and silver and general chemical practice	200,000
Total	3,250,000

In the manufacture of phosphatic fertilizer, phosphate rock is treated with sulphuric acid to render the phosphoric acid soluble. One ton of rock phosphate requires treatment with about one ton of 50 deg. Be sulphuric acid.

In refining petroleum products, sulphuric acid 66 deg. Be and sometimes fuming acid is used for the removel of tarry matter and to some extent sulphur compounds. For example, one thousand barrels of illuminating oil requires for its refining about two tons of oil of vitriol.

In the iron and steel industry, very dilute sulphuric acid, free from arsenic, is used for cleansing steel plates or wire preliminary to galvenizing, making conperas as a by-product; also the steel companies have gone extensively into the production of coke with by-product coke ovens, one of the products of which is sulphate of ammonia, which requires a little over a long ton of 50 deg. Be sulphuric acid for each net ton of sulphate of ammonia produced.

In the manufacture of nitrocellulose, nitro-glycerine, etc., highly concentrated or contact sulphuric acid is used in connection with strong nitric acid to absorb water formed during nitration which would otherwise interfere with the chemical action desired.

In the manufacture of alum, either bauxite or white alumina, are treated with 50 deg. Be sulphuric acid, free from arsenic, to form aluminum sulphate

In the manufacture of sulphate of ammonia, ammonia gas is absorbed in scrubbing towers by dilute sulphuric acid or solutions of ammonia are treated direct with sulphuric acid.

In the manufacture of blue vitriol, metallic copper is dissolved by hot sulphuric acid, very dilute. Dilute sulphuric acid is also used to some extent in leaching copper ores, concentrates or slimes for the recovery of copper values.

No attempt is made to give a complete category of the uses of sulphuric acid, but enough has been specified to show the distribution of lines of manufacture which require sulphuric acid.

Phosphate rock deposists are in Florida, Tennessee, and South Carolina. There are also deposits of phosphate rock in Utah and elsewhere in the western states, which will have great industrial importance as soon as the demand for phosphatic fertilizer in the west has grown to a point to justify the erection of fertilizer plants.

The location of fertilizer plants is decided by the following facts:

The phosphate rock has, in any event, either acidulated or not acidulated, to be transported rom phosphate deposit to agricultural district where it will be consumed. The complete fertilizers can be manufactured near the point where the fertilizer will be used. Therefore, a determining factor in the location of phosphatic fertilizer works is the freight on sulphuric acid or crude material from which it is manufactured.

One ton of pyrites containing 50 per cent suphur will produce 2.35 tons of 50 deg. Be sulphuric acid, so that it is cheaper to transport iron pyrites than to transport the quantity of 50 deg. Be sulphuric acid which a given amount of iron pyrites would produce.

Sulphuric acid plants in connection with fertilizer plants are therefore generally located adjacent to the agricultural district where the fertilizer will be consumed and not near the deposit of phosphate rock, and combined sulphuric acid and fertilizer plants located near phosphate rock deposits are there merely to supply agricultural requirements in that vicinity. Combined sulphuric acid and fertilizer works are therefore located in parts of the United States where phosphatic fertilizer is required.

Fertilizer is extensively used in connection with the growing of cotton, and the southern states, denoted as cotton growing states, contain very numerous sulphuric acid plants.

In the northern and eastern states, the use of phophatic fertilizer is not so extensive and a less number of combined sulphuric acid and fertilizer plants supply the demand.

The consumption of fertilizer, other than in the western states, is growing so enormously that a most unusual business situation is developing, and even in Utah combined sulphuric acid and fertilizer plants are now contemplated.

Much the greater portion of sulphuric acid produced in the United States is made from iron pyrites.

During 1911, pyrites was supplied from the following countries:

	Net tons
Spain	815,000
Portugal	133,000
United States, Canada, about	350,000
Total	1,208,000

Of this amount 584,000 net tons were delivered to plants in the south manufacturing sulphuric acid exclusively for the production of fertilizer, and 236,000 net tons were delivered to plants in the north manufacturing sulphuric acid exclusively for the production of fertilizer.

These quantities of pyrites would represent a production of sulphuric acid in the fertilizer plants in the southern states of about 1,300,000 tons of 50 deg. Be sulphuric acid, to which should be added 275,000 tons of 50 deg. Be sulphuric acid produced as a by-product by the copper smelters in Tennessee, practically all of which is consumed in the manufacture of fertilizer in the southern states.

The 236,000 tons of pyrites delivered to plants in the northern states, manufacturing sulphuric acid exclusively for the production of fertilizer, would represent 529,000 tons of 50 deg. Be sulphuric acid.

In addition to the above fertilizer-acid, considerable quantities of sulphuric acid are manufactured in works doing a general chemical business and shipped to

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fertilizer works for treatment of phosphate rock, also sulphuric acid separated from sludge acid from petroleum refineries is shipped in considerable quantities to fertilizer works, bringing the consumption of sulphuric acid in the fertilizer business up to the total figures given above.

In the petroleum industry the consumption of sulphuric acid has increased slowly for some years, for the reason that the oil refineries have learned to economize in sulphuric acid and have decreased the quantity used per barrel in refining to largely offset the large increase in the production of petroleum products. For example, previous to 1888 in many oil refineries sulphuric acid was mixed and stirred with distillate only once, being then at once diluted and separated from the combined tarry matter and again concentrated to 66 deg. Be before using again in the oil refining process. In 1890 the practice came into general use of using sulphuric acid a second time, taking the acid from a previous treatment of distillate and using the partially exhausted acid on a second batch of distillate before separating and concentrating. This materially reduced the consumption of fresh acid.

Again, about the year 1896, the use of Fuller's earth was introduced in oil refining practice. Tarry matter was removed from distillate by agitation with Fuller's earth and a decreased amount of work remained to be done by sulphuric acid treatment. These two improvements made a material reduction in the use of sulphuric acid in oil refining. Subsequent improvements in method and practice in recovering sulphuric acid from sludge or spent acid have further reduced the net consumption of fresh sulphuric acid by the petroleum industry.

The location of acid plants supplying oil refineries is quite uniformly adjacent to the oil refineries on account of the transportation problem.

Transportation of crude oil by pipe line is so much cheaper than the transportation of refined products by rail, that oil refineries under conditions in the United States are located with reference to transportation and distributing of the refined product and seldom adjacent to oil producing fields, except only to supply the demand for the finished product in the radius of economic shipment from the oil fields. The great oil refineries are, therefore, chiefly located where there is both rail and water transportation. There are oil fields in Pennsylvania, Ohio Indiana, West Virginia, Indian Territory, Texas, California and some other States. The large oil refineries, however, are located along the [illegible] seaboard on the water front near New York harbor, Philadelphia and Baltimore; along the Great Lakes at Buffalo, Cleveland and near Chicago; on the Pacific coast, on San Francisco bay. Minor oil refineries are located near the oil fields. In every case sulphuric acid plants are located near the oil refineries. The group near New York are supplied from a large chamber-process sulphuric acid plant on New York harbor, operated by the petroleum refining interest, with an output of about 60,000 tons of oil of vitriol per annum. Oil refineries at Philadelphia and Baltimore are supplied with oil of vitriol from a sulphuric acid plant at Philadelphia delivering about 40,000 tons of oil of vitriol per annum. The California crude oil requires treatment in part with an acid stronger than oil of vitriol, which is supplied from an oxide-of-iron-contact plant at the oil refinery, on San Francisco bay.

One small refinery adjacent to the Texas oil fields burns brimstone from the Louisiana sulphur deposit.

In many cases, the oil refineries or chemical companies supplying them with sulphuric acid are equipped with appliances for separating sulphuric acid from the tarry matter taken up in the treatment of petroleum distillate and the separated acid 35 deg. Be and 50 deg. Be is then again concentrated to 66 deg Be for further use. This repeated restoring of the spent acid greatly diminishes the amount of fresh sulphuric acid required by the petroleum industry and brings their net requirements down to the figure given above.

Mention should also be made of a practice by the petroleum refiners to a very limited extent of manufacturing sulphuric acid from sulphuretted hydrogen and sulphur dioxide fumes given off during the distillation of petroleums high in sulphur contents. In general, it may be said that the fresh sulphuric acid consumption by the petroleum refining companies represents chiefly the actual decomposition of a percentage of the sulphuric acid used by reduction to SO_2 by the carbon in the oil treated, plus deliveries of separated sulphuric acid 50 deg. Be gravity to fertilizer plants. In addition to the mechanical loss in use, there is actual decomposition to SO_2 during treatment, especially of heavy oils, and also the decomposition is considerable in the process of separating and reconcentrating the sulphuric acid.

Counting the repeated use of sulphuric acid by the petroleum industry, their actual use of oil of vitriol would be about 334,000 tons per annum, representing 500,000 tons of 50 deg. Be equivalent.

The iron and steel industry uses such considerable amounts of sulphuric acid that a tendency is developing for steel companies to erect and operate separate sulphuric acid plants.

The manufacture of sulphate of ammonia from by-product coke ovens has also been taken up by the steel companies. A coke plant consuming 2,000 tons of coal per day would produce from 14 to 30 tons of sulphate of ammonia daily, according to the nitrogen content of the coal used. Therefore, each 2,000 tons of coal, high in nitrogen, converted into coke daily, would call for a sulphuric acid production of 10,000 tons of 50 deg. Be sulphuric acid per annum.

The location of sulphuric acid plants to supply this demand has so far been adjacent to the steel plants in Pennsylvania, Indiana, Michigan, and Alabama.

By-product coke ovens are now being built or under consideration which will require 100,000 to 150,000 tons of 50 deg. Be sulphuric acid per annum, in addition to the figure shown above. This development has so far been chiefly in connection with iron and steel industry.

One of the sulphuric acid plants operated by one of the steel companies burns brimstone from Louisiana, the other burns pyrites. All so far constructed have been chamber-plants, although one by-product plant now being built has contracted for its supply of sulphuric acid from a concern producing contact acid.

In the manufacture of nitrocellulose, nitro-glycerine and similar products, the chamber process has been practically eliminated by the contact process. Contact process has been installed wherever these explosives are manufactured. Several iron-oxide contact plants have been erected for this purpose as well as other contact systems.

In the general chemical industry, the various platinum and iron contact systems have made considerable progress, more especially where the demand is for sulphuric acid approaching the composition of the monohydrate.

Out of a total production of sulphuric acid in the United States of 3,250,000 net tons per annum, approximately ten per cent is contact acid made either by the iron-oxide contact or by the platinum contact systems.

Of the Spanish pyrites imported during 1911, namely, 815,000 tons, 37 per cent was copper bearing pyrites, of which about 200,000 tons were chloridized and leached for the recovery of copper values, after burning off the sulphur for the manufacture of sulphuric acid.

Of the 646,000 tons of iron pyrites imported during 1911 containing no copper values, about 230,000 tons was washed fines from which copper had been leached in Spain or Portugal before shipment to this country.

The practice of nodulizing cinder from pyrites burners has become general in all

localities where there is a market for the nodulized cinder as iron ore. The iron industry of Pennsylvania furnishes a good market. In Alabama the iron manufacturers have not as yet offered prices for low phosphorus nodulizing kilns and there is in the south the accumulated cinder from years of sulphuric acid manufacture, waiting for prices which will make its utilization profitable.

An analysis of the source of sulphuric acid manufactured in the United States during 1911 would show as follows, figures given being expressed in terms of 50 deg. Be sulphuric acid:

	Tons.
Manufactured from pyrites	2,665,000
Manufactured from blast furnaces, smelting copper sulphide ores	275,000
Manufactured from zinc sulphide ores	285,000
Manufactured from brimstone	25,000
Total	3,250,000

SUCCESSFUL MARKETING OF MINING PROPERTIES

A good mining property has a market if properly presented, and that market is getting better every day, says Carney Hartley, a Denver mechanical and metallurgical engineer, in a recent issue of Mining Science. It may sound strange to the ears of people who have been unsuccessful in selling their properties to be told that there are fully as many buyers as there are mines which a conscientious and discriminating salesman would care to offer to a customer.

To make this matter plain, we must consider what constitutes a good mining property from the standpoint of the salesman. From the owner's standpoint this is an easy question to answer. A good mining property is one which has a reasonable development showing good values, with geological conditions indicating that a body of ore exists, and with good surface conditions for handling the mine product. It is sufficient for the purpose that he knows these facts, as they are the prime essentials in the case, but from the financial or investor's standpoint, a mine is more than this, very much more, and it is the purpose of this paper to try and explain what this is and to make plain the reasons for requiring a lot of apparently useless information.

When we attempt to sell anything in this day and age, we must not only have the goods to begin with, but we must know all about them and have this information in shape to present to the customer in a clear, logical and convincing manner. Salesmanship no longer counts customer as a victim but rather as an asset, and as such nothing but the fairest treatment can be considered. This same idea, in a practical way, would hold in the sale of mining properties, as every successful property handled means advertising and a resulting wider field for the salesman.

Experience has, however, shown the need of certain modifications of the usual situation considered from the selling standpoint, and it is well to have these understood in the beginning. In almost every line of industry the reputation of a man or an article means much to the success of the sales, is almost vital, in fact, and so well is this recognized that honesty is the prevailing policy in such cases even though it may be lacking personally. In considering the purchase of mining properties, the investor takes it as quite as much an axiom that no owner of mining property can tell the actual truth about it, and his report is scarcely considered in forming an opinion. No doubt there is justification for this; irresponsible promotions, wild-catting, over confidence, extravagance and, last but far from being least, ignorance, have all militated against the owner in creating this condition of affairs, in other words, making him the "goat." It is necessary then to consider this as a fact of the case and make our consideration with it in view.

This being accepted, let us look at another phase of the case. This is a day of low grade ores; economy and conservation must be considered more and more. Ore must be handled in increasingly large quantities and this to the investor presupposes large bodies of it. Investment and return must be based on this condition as a first requisite after values. In other words, this is the real prime essential from the financial standpoint and must be determined in order to have intelligent ideas and arguments for interesting capital. Following this is the question of treatment, as it is always possible to find a method that will be satisfactory; but if there is no ore, nothing can be done.

In the days of bonanza mining, returns were quick, mine investment was high, equipment investment low. The mine fixed its own value. We are confronted now with a very different situation. The property fully equipped is worth so much money as an investment and the mine itself is worth the difference between the cost of the equipment and the total investment that the property will stand. This is, in a nutshell, the situation. The equipment has become paramount as a consideration, and "ore in sight" an essential to consideration of what is proper and necessary for its working.

Along this same line there is another point for consideration. The salesman wants and needs full information in every respect, for reasons which are altogether different from any personal to himself. Low grade properties usually demand a great deal more capital for their equipment and operation than one man will risk in an enterprise. Consequently, it is usual, in the beginning at least, for him to ask his friends to help him out. In such case they rely on his personal judgement alone, the promise of early realization and good return when the securities are marketed, giving the proper business aspect to the situation. Under these conditions, he has to make good not only for business reasons, but for moral ones also. It is not, therefore, surprising that he should demand full and complete information before spending any money himself or asking aid from his friends; that he should want to know what he is buying or expected to buy and want it in such shape that he could pass it along with intelligence and confidence. And, in the beginning, the salesman has to supply all this information and to present it in a convincing manner without any slips that might show inconsistencies or raise a suspicion of past failure not clearly stated and explained. He must be very sure that his facts are exactly as they will be found on the property, and if they are found to be somewhat better than stated, so much the better. And a good salesman is not necessarily an engineer, generally is not.

But what frequently happens when the details of this information are asked for? As an instance coming under the writer's observation, an effort, extending over a considerable time, was made to find a certain kind of property where the market was all ready. The specifications were carefully prepared by competent people and sent out whenever the opportunity arose. Something like fifty properties were presented for consideration, but not one of them was in condition to be put up to the customer. In many cases, the preliminary information was very incomplete and requests for additional information were completely

ignored. Many of these replies showed the properties to be mere prospects with the only information that supplied by the discoverer. In some instances, definite information as to the values were even lacking, the one thing which should in this case have been most prominently stated. Taking them all in all, they showed a lack of preparation for sale; too many of them, the old spirit of getting something for nothing.

This is a very strong example of what has been shown in other cases and shows the evident need of training the mining public to the needs of the case. Not a training to sell their own mines, but one in showing the needs of the man who will try and do it for them. Vast sums of money and tons of advertising paper are used to market an article which sells for 5 cents per unit. The same kind of action would not be needed to sell a mine, but it is along the same lines. Time enough to justify expenditure for advertising in some form and take care of the known fact that it is almost impossible to hurry the matter from any side. Time for examination and sometimes for a second one, consultation, organization, all must be considered and allowed for. Too often the failure of an irresponsible salesman condemns all of them when a very little effort would have shown the mistake before its making. Very little can be hoped from 30 or 60-day options under the usual conditions, as it gives no chance to cover the field in any manner and does not warrant advancing the money necessary to bring the property to the attention of the people who might be interested. In this country, with the business always on a contingent basis, this is a consideration. Capital is very shy and must be hunted out, while mining is only one of hundreds of forms of investment always hunting. Mining as a general form has very little standing, and its attractiveness must be shown for the individual property. It is just as necessary to tell the story properly as to have something worth telling about, keeping in mind, however, that plain facts sound best and that anything you say will be used against you if possible. Generally speaking, recommendations for equipment are of little value and confuse the main idea, unless accompanied by good reasoning and evident knowledge of the requirements. The real thing is to have something which has the conditions and which you can show has them, and which you have in shape so they will show themselves. To have a property turned down only adds to the difficulties and should not be risked by premature offering

WHAT IS COAL LAND

It is so often the unpleasant duty of the United States Geological Survey to refuse to reclassify as noncoal land areas that have been classified as coal land, because the evidence and affidavits submitted for reclassification are inadequate, that a word of explanation on what is considered "adequate" may make clearer the position of the Survey in the matter.

It is a widespread popular impression that if coal is found outcropping on a tract, the land is coal land, and that if no coal is to be found outcropping the land is non-coal land. If this were true probably more than one-half of the coal produced in the country (in some States more than 95 per cent) would be coming from mines not on coal land.

As an illustration, 196 miles in Indiana in 1908 produced 11 997,304 tons of coal. Of these 196 mines, 15 were working the coal from the outcrop and produced 400,733 tons, or a little over 3 per cent of the total. The rest was mined from land, the surface of which showed no coal. In Illinois the percentage is still less, and in both States the average production of the mines working on the outcrop is small, compared with the average of all the mines. The percentage of coal worked from the outcrop is greater in Pennsylvania, West Virginia, and the southern Appalachian States than in the two cited, but not much if any greater in the Michigan field, the western interior field, or some others of the large fields of the country. It is true that in many of the fields when first exploited mines were mostly driven in on the outcrop, but for two reasons that condition has greatly changed. First, the coal close to the outcrop has been mined out; and second, after a time it has been found to be cheaper to mine the coal from shafts sunk to the bed from a point some distance back from the outcrop than to haul the coal, water, and waste up the slope of the bed as it pitches into the ground

If, therefore, any producing coal field is examined there will usually be found a belt of outcrop in which the coal-bearing rocks rise to the surface of the ground, and outside of that belt an area, which may amount to thousands of square miles, where the coals are all below the surface and the surface rocks may even be of entirely different age and perhaps not coal bearing at all. In Indiana shafts have been sunk to coal beds at a depth of 250 feet without any preliminary drilling where the coal bed did not outcrop nearer than 15 miles, and many of the mines of Illinois are 25 to 50 miles from the nearest outcrop of the coal they are working.

In classifying land as to its coal character a few general principles are involved:

1. If the land is known to be underlain only by groups of rocks known nowhere to contain coal, the land is assumed not to be underlain by coal and to be non-coal land.

2. If land is known to be underlain by one or more groups of rocks known to contain workable beds of coal, and a study of the dips shows that those groups are not too deep for the coals they contain to be worked, the land may be presumed to be coal land.

In nearly all cases where public lands have been withdrawn pending examination and classification it is known or believed that the land is underlain by groups of rocks known elsewhere to contain workable beds of coal. In probably a majority of cases it is also known or later examination demonstrates that coal does not outcrop on most of the land withdrawn but underlies it, perhaps at a considerable depth.

The evidence obtained by the Survey consists of observed outcrops and measured sections, properly located and described on the spot, and analyses made in the Government laboratories from coal samples collected in a definite prescribed way, supplemented when necessary by such second-hand data as appear to be accurate and reliable and to be in accord with the personal observations of the field men.

A party from the U. S. cruiser Maryland is now inspecting the Matanuska coal fields of Alaska, from which it is purposed to obtain fuel for the navy coaling station at Seward.

In diamond drilling the core spring sometimes fails to work properly, and the core is left in the hole. It may be picked out, but a better way is to break it up with a chopping bit when it can be washed up.

A Salt Laker the other day informed a friend that he had 1000 shares of Butte & Superior for which he paid $18 a share and sought advice as to what he ought to do with it. "I must not advise you," replied the friend. "A few yeads ago a friend of mine bought some Newhouse at $8; when it reached $18 he asked me what I thought he ought to do and I advised him to take the splendid profit it then afforded. He did so, but when the stock rose to $26 he upbraided me and bought more. I immediately retired from the advice-giving business and I am still out.

Mines and Methods

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CONTENTS:

"DE CHUTE EN CHUTE"

Following the publication of Utah Copper's fourth quarterly report for 1912 French and English papers have been discussing the company's affairs, and particularly as they related to the claims of increased earning power and promises of greater dividends. The Paris Globe (the Frenchmen's financial Bible) of February 27, after briefly explaining what the Utah Copper situation appeared to be, closed by saying: "Certain English journals are advised that the dividend could be increased. We are unable, however, with any certainty to share that opinion, since the shares have tumbled ('de chute en chute') during the last six months from 350 to 270 (francs)."

In other words the Frenchmen argue—very properly—that neither the company's mining record, nor the action of the stock, marketwise, indicate honesty in the claims made for the proposition.

Commercial Club Tackles The "Smoke" Problem

The people of this city and valley are to be congratulated upon the fact that the board of directors of the Commercial Club have recognized the necessity of determining a means of eradicating the so-called "smoke evil" with which the valley population has to contend. The initial step was taken on the seventh day of the present month, when a discussion of the subject was followed by the adoption of the following preamble and resolutions:

Whereas, the smoke problem in Salt Lake has assumed such serious proportions that it not only is a menace to the health and comfort of our citizens but also threatens the city's commercial prosperity and its attractiveness for tourists, therefore,

Be it Resolved, That the Commercial club is in favor of any reasonable means to abate the smoke nuisance or to mitigate its evil effects. In order that something tangible may be done, be it further

Resolved, That the president appoint a committee of three members of the club, whose duties and powers shall be as follows:

1. To make a careful, thorough, scientific investigation of the origin and cause of the smoke, and to determine whether there is any remedy for the condition.
2. To co-operate with the city, county and state authorities in this task, if such co-operation can be obtained, otherwise to proceed independently with an investigation in behalf of the Commercial club.
3. To employ expert aid for the purpose of ascertaining the chemical and physical properties and effects of the smoke, observing air currents, and studying questions of combustion; and also for the purpose of calculating the financial effect of the present deplorable condition, and of carrying out any proposed remedy.

The committee appointed by the president of the club is composed of gentlemen in whom the utmost confidence can be reposed, gentlemen with experience, ability and energy enough to properly and speedily perform the task assigned to them: Messrs. George H. Dern, O. E. Howard and James H. Moyle. To make the investigation thorough, comprehensive and effective, and to make possible the application of a remedy that will settle the matter once and for all, this committee must have the moral support of the community and the press. There should be no quibbling or attempts at evasion on the part of the "moulders" or "reflectors" of public sentiment. If we are to prove to the world that Salt Lake is what is so insistently claimed—the most inviting spot on the continent on which to establish a permanent residence—every vestige of evidence that would tend to controvert that claim must be destroyed. Surely the newspapers, the city and county officials, the real estate association, the association of women's clubs and every citizen with a claim to civic pride and possessed of a desire to see this splendid city grow and prosper, can labor in harmony for the cause.

For more than three months past Mines and Methods has been doing everything possible to awaken public sentiment and get a movement started that would accomplish the object in view: that of making Salt Lake in reality, as well as name, a beautiful, clean city. There has seemed to be some resentment of the attitude taken by this journal because it has contended that the greatest blame for the smoky, foggy, murky condition of the atmosphere here during the past several months, was chargeable to the smelters operating close to town. However, it must be conceded that we have delved deeply into the subject and that, for every assertion made evidence—unimpeachable evidence, we believe—has been presented to substantiate it. In this issue we present considerable data and matter of an explanatory character that was accumulated by Mr. Alter during his evidence-compiling campaign and we hope that its presentation will be given the consideration it deserves at the hands of those who have now been officially charged with seeking a final solution of the problem and the complete eradication of the nuisance.

During the present month much space has been devoted by the daily press to the work of the Women's Clubs to make Salt Lake a "clean city." We commend every act that has so far been performed and endorse every word that has been uttered. We regret, however, that the inaugurators of the campaign have entirely overlooked the chief cause of this city's uncleanliness and that the papers have seemed loth to bring it to their attention. It is all right to have a general spring clean-up of premises, the removal of unsightly objects, etc.,

and thus present the city's brightest side during the good weather months of the year; but, if we are to impress visitors and the great mass of traveling humanity that enters and passes through the city during the fall and winter months, with the idea that Salt Lake is a charming place, we must so regulate conditions that people can not leave here with stories to the effect that this valley's atmosphere was so charged with sulphur fumes, smoke, soot and fog that it was impossible to breathe without choking, see any distance or appear in clean linen without besmirching the same; we must do everything possible to make the atmosphere in which we live purer and cleaner.

If any of the people of this city believe or have been urged to believe that Mines and Methods has not honestly or properly diognosed the case, we urge them to select some morning when the atmosphere is heavy, between six and nine o'clock, and when there is a gentle breeze blowing from the south, to go out on the bench to the east or north of the city and watch the smoke and fumes from the valley smelters roll into this town. If it is inconvenient to make these excursions, at least go into the north and south streets anywhere from Main street east, and observe what is happening there. Inhale and taste the "fog" that envelops you; note how the damp, heavy soot is being thrown down by this sulphurous "fog" and then decide whether this journal has had cause to place the blame where it has placed it. Go out in the afternoon of such days when a wind from the northwest is sweeping along the west side of the valley and note how the smoke and fumes from the Garfield smelter are carried along the foothills to the south until it is caught up by the currents drifting through the Jordan narrows and is driven back to join the fumes, gases and smoke from the Murray and Midvale smelters in the procession northward again. Don't be persuaded to make these investigations just at a time when heavy winds have swept the landscape and temporarily cleared the atmosphere; go when the trouble is in evidence and learn for yourselves what it really amounts to; go, if you can, at a time when you know that fires are out in town, before the city furnaces and stoves have had a chance to participate. Then, if you find that the "fog," "smoke" and "murk" is there, just the same, accord to us honesty of purpose in making the fight we have made to have something done, and urge the Commercial Club's committee to brave everything in a determination to make Salt Lake, in fact, "a clean city."

And in all earnestness and all good faith we respectfully suggest to the Commercial Club special committee, the Real Estate association and others who are vitally interested in this matter, that if the sentiment is found to be that, while the difficulty can be traced to the smelters, it is against the best business interests of the community to make them move or cease causing the trouble, we get together and work for more smelters. Let us advertise the city as a Pittsburg and make a feature of the amount of "smoke" we can make. Mines and Methods has some large, panoramic views of the city that might be employed to advantage in advertising such a feature and, if that is what is wanted, let us all get together and present our claims for outside recognition on that score. We can supply these pictures. It must be one thing or the other—the two propositions can not be made to work in harmony.

As it stands, we are for a "clean city." Now, let's have the evidence officially presented and then take a standing vote.

"UNTRAMMELED" MINING PRESS

The attention of "Managing Editor Jackling" and his string of sub (and subsidized) editors and prudential reporters (as well as the public) is respectfully called to the "treasonable" utterances contained in the following editorial from the Engineering & Mining Journal of February 22d—last month. We have been taking particular pains to note whether Hayden, Stone & Co., George L. Walker, the Boston News Bureau, the Salt Lake Tribune, Telegram, Herald-Republican, the Salt Lake Mining Review, or any of the rest of the boasted purveyors of "legitimate mining information"—East and West—have had the nerve to reproduce, commend or criticise this article And the search has been unproductive. The issuance of the company report which has called forth this wholesome and perfectly justifiable comment of the Journal caused a wave of consternation to roll through mining investment channels everywhere and yet the very publications that ought to be most interested are either afraid to speak up, or are paid to maintain silence. Is it not laughable? To more particularly emphasize some of the points made in the Journal's editorial we have taken the liberty to have some of the words and expressions placed in capital letters:

> The report of the Utah Copper Company for the fourth quarter of 1912 is AN ASTONISHING DOCUMENT. The production fell off to less than one-half of what it was in the second and third quarters, such was the effect of the strike; and the cost of production, as computed by the company, rose from 7.707c. in the third quarter to 14.83c. per lb. of copper in the fourth quarter! This is explained by the decreased tonnage of ore treated and by the lower grade of the ore, which in turn is explained by the necessity of procuring the ore from the low-grade and only partially stripped areas. Anyway the average assay in the fourth quarter was only 1.104 per cent copper against 1.41 per cent in the previous quarter. So large and sudden a drop can only be explained by some extraordinary occurrences, such as the president and general manager indicate in their last report, but it is decidedly disconcerting that in the affairs of this company SO MUCH EXLAINING has to be done, SO MANY EXCUSES have to be made.
>
> The Utah Copper Company is now in its sixth year as a producer, disregarding its preliminary work at Copperton, and during that time it has failed to develop in its annual and quarterly reports any of the steadiness that has been displayed by Nevada Consolidated and Miami, the other great porphyry producers. Five years ago the Utah ore was promised to average 2 per cent copper THAT FIGURE NEVER HAS BEEN REALIZED during a year's operations and while we know it is going to run much less than that, we don't yet know what the actual average is going to be. Nor do we know what the actual average cost of production is going to be, although WE HAVE INCREASING CONFIRMATION OF OUR SUSPICIONS that it is going to be much higher than the 7 or 8c. per lb. that used to be estimated. A variation of 7c. per quarter in the case of a big company is almost unprecedented AND INDICATES AN UNCOMFORTABLE BALANCING OF CONDITIONS, which probably has never been adequately taken into account.
>
> Thus, the labor situation in Bingham since early in September has been very troublesome. There was a strike over the matter of wages. This has been settled, but a shortage of labor still prevails. The present explanation is that men have gone home to fight the Turks. It may be perhaps that PRESENT WAGES EVEN DO NOT ATTRACT THE SUPPLY OF LABOR THAT IS NEEDED AND THAT THE COMPANY CANNOT COMFORTABLY STAND ANY FURTHER INCREASE. These are matters that the Utah Copper Company does not touch upon in its reports.

CROSSING THE WIRES AT ALASKA GOLD MINES

Judging from the statements emanating from official sources the promoters of the Alaska Gold Mines "enterprise" would do well to send out a gang of surveyors to definitely locate the Sheep Creek tunnel. General Manager Jackling has repeatedly said that this tunnel was being driven from a point on the Gastineau channel at the mouth of Sheep Creek and up to the first of the present month no one had taken issue with him on that point, and we still believe that he is right. According to a Geological Survey map which shows the Perseverance claims and the other groups of properties in the Gold Basin section, as well as the Sheep Creek divide and the approximate location of the mouth of Sheep Creek canyon, if the Sheep Creek tunnel was driven in a straight line to get under the Alexander tunnel and shaft workings—its admitted objective point—its course would be practically due north.

However, Hayden, Stone & Co., in a market letter about the first of the month, knocked these calculations into a cocked hat. After describing with con-

siderable detail the character of the development in the Alexander tunnel workings in the Perseverance ground, the letter goes on to say: "Now, 10,000 feet to the EAST of these Perseverance workings and 700 feet below them, the Sheep Creek tunnel has entered this deposit. The tunnel has been turned to parallel the vein," etc.

We don't care to get deeply mixed up in this question of location, because it makes no difference to us one way or the other. But you people who may be contemplating the contribution of your mite toward the successful flotation of the scheme in the belief that you will some day get your money back, at least have a right to know whether that tunnel is being driven from the east or the south; and it is also worth while to know what claim the company has to the deposit that Hayden, Stone & Co. contend has been entered by this Sheep Creek tunnel "10,000 feet to the east of the Perseverance workings and 700 feet below them," providing the deposit contains anything of value.

We mention these discrepances particularly because they serve to illustrate how little the promoters of this proposition care what character of "dope" is peddled out to the public, so long as it "LOOKS BIG and will have a tendency to "get the money." In the various statements put out by Manager Jackling, Hayden, Stone & Co., George L. Walker and others during the past few weeks, other misstatements and inaccuracies just as glaring as the ones noted could be pointed out, but what is the use? The publicity agents of the promoters will be pouring "hot shot" into the ranks of the "investors" by the cartload between now and June, when the second payment of $5 per share will be due, so there will be ample opportunity for further comment.

When intelligent men like newspaper editors, city officials, educators and so forth, read carefully through the smoke studies made and published by Mines and Methods, showing beyond the last vestige of doubt that the smelters are the nastiest of our smokers, and will then advocate an "investigation" to find out where the smoke comes from and otherwise indicate a lingering disbelief, we are reminded of the old farmer at the circus, who had stood in studious silence for several minutes looking at the giraffe. After having critically eyed its uneven legs, its odd sloping back, its derrick-like neck, its dreamy eyes, and its flexible hand-like lip, he at last turned away in disgust, remarking, "Shucks, they can't fool me; there aint no such animal!"

Most of the tin produced comes from alluvial deposits.

"Garfield" Milling Methods a Failure

In reference to the article on the "Management's Apologies for Butte and Superior" appearing elsewhere in this section of Mines and Methods, and which explains the actual conditions obtaining at that property, we are fully substantiated in all our estimates and criticisms of this "great enterprise" by circumstances which have developed within the past few days, notwithstanding Manager Jackling's assurances given in the published interview contained in the Boston News Bureau of the twelfth ultimo.

> **"The attempt to treat the Butte and Superior ores by the Utah Copper methods has been admitted a complete failure by the management. The Garfield mill practice employed is to be abandoned. A new mill superintendent is coming from Missouri."**

The above in substance, clearly outlines the situation at Butte and Superior as contained in telegraphic advices to Mines and Methods from Butte as we go to press.

In consideration of this latest development we wonder what Hayden, Stone & Company, the Butte and Superior stockholders, and the general investing public, now think of the information contained in published interviews by the management, and in the "bankers" market letters, in which numerous statements were made, unreservedly, that the Utah (Garfield) system of concentration had solved the problem of successfully treating the Butte-Superior zinc ores; that an increased tonnage of ore could be treated, and that a recovery of 85% of the zinc mineral content of the ore was being made which, on the basis of treating 36,000 tons of ore monthly, would return a net profit of $200,000 per month. Compare the actual results obtained from the operation of the Garfield system of concentration (which have been given in Mines and Methods for the past three months) with the claims of the management, and the absolute necessity for the action taken (as outlined in the above mentioned telegraphic dispatch) will be apparent. However, it must not be considered as final that the appointment of a new superintendent will effectually clear the mechanical, metallurgical, or financial atmosphere surrounding the property, and permit the recovery of the stock market to a price above its present quotations. To the contrary, it should be borne in mind that there was not, nor can there be, a time, regardless of the managerial or engineering direction of the Butte and Superior properties when the real value of the stock—based upon the legitimate earning-capacity of the mines—would justify the command of anything like the present market quotations for its stock. This will be apparent when we consider that the mine, according to the management's own statements, does not contain a sufficient tonnage of ores of commercial grade, and that even under the most efficient management, economic conditions preclude a low production cost of zinc.

It is a matter for congratulation, however, that the sponsors of Butte and Superior have been able to evade in this instance the hypnotism under which they have been laboring so long, sufficiently that an effort is now being made to save something from the wreck.

Finally, without dwelling too long on the subject, we want to ask our readers, Hayden, Stone & Co., Geo. L. Walker, the Boston News Bureau, the Guggenheims, S. W. Eccles, and all the rest of the hypnotized following of the practical jokers who have been posing, and have been posed, as the "greatest engineers in this or any other country," where they expect Utah Copper, Ray, Chino, and Alaska Gold Mines, to land. Let's hear from you. Space in Mines and Methods is at your disposal.

Management's Apologies for Butte and Superior

In the January and February issues of Mines and Methods attention of readers was called to the actual operating conditions at the Butte and Superior property under the new management, which is largely composed of the same element which dominates Utah Copper, Chino Copper, Nevada Consolidated, Ray Consolidated, and Alaska Gold Mines. The information published, which clearly outlines the actual facts, was derived chiefly from the offical records of the Butte and Superior company, and is representative of its operations despite the statements in contradiction thereof by the new management, through published interviews, and by the "bankers" through market letters

Under date of February 12th., 1913, the Boston News Bureau published an interview with Mr. D. C. Jackling which purports to be a thorough explanation of the Butte and Superior situation, and from which we quote:

A year or so ago Hayden, Stone & Co., in behalf of their associates and clients, acquired a substantial interest in the Butte & Superior Co. At that time certain work was being done in respect to the metallurgy of the ores, and plans had been prepared for the construction of a new mill along lines which it was hoped would solve the problem of extracting zinc at a satisfactory commercial profit from these high-grade (20%) but refractory ores. The people then in charge were very sure of their ground, and we did not feel that we should interfere too strenuously and make too many suggestions until they had demonstrated what they could do.

They built a mill and started it up on a small scale of operations getting fairly good results, but these results could not be secured on large tonnages, and of course, the big mining profits are made only when milling plants are run at maximum capacity.

At this juncture, I and my engineers looked into the proposition very carefully, and suggested some changes that were made. We had previously insisted that the arrangement of the buildings should be such that capacity could be easily increased, and an orderly arrangement of operating units provided. The tonnage treated at that time was relatively small and the various departments of the mill did not work harmoniously; it was like a strong chain with weak links in it.

There was, however, some excuse for all this. It was a new proposition, and never before had an attempt been made to treat this particular character of ore on a huge scale.

We have now been working on the proposition until we feel that we have solved all fundamental problems, although we are yet to determine just what rate of extraction will be the most economical and it takes time to develop and apply improved methods and arrangements and to perfect adjustments of them. All sorts of sensational recoveries can be made in laboratory or experimental tests; it is quite another matter when a large volume of ore is to be concentrated. We are now not only on a commercial operating scale so far as metallurgical results are concerned, but on a profitable [illegible] We were delayed in the receipt of our compressor, new hoisting engine, and in the matter of underground transportation facilities. These delays, however, are not unusual, and the impatient stockholder should always have the "delay" contingency in mind. The consequence was that we did not start up our new hoist until a month and a half ago and we have only been in real operation since about the first of January.

Today we are getting better than an 80% extraction, and I believe that within a few months we will be able to work the proposition up to the point of handling 1200 tons per day, with a higher yield from the ores, and at a cost which will be entirely satisfactory.

Last month we produced over 5000 tons of concentrates, or 5,000,000 pounds of zinc. We produced 18,000,000 pounds of zinc last year.

In March we hope to treat 800 tons per day with a production of 7,500,000 pounds of zinc and to gradually increase this up to 1200 tons per day. The daily treatment of 1200 tons of ore, or 36,000 tons per month, should yield us over 10,000,000 pounds of zinc in concentrates.

Manager Jackling's review of the Butte and Superior situation as outlined in the above should not be given serious consideration—in short, no consideration whatever—if the actual facts are desired. In reference to the construction of the original 1,200-ton concentrator on the property, it is advisable to call attention to the fact that the original plan of concentration therein installed was based upon the most modern practice for treating zinc ores; that it had been thoroughly worked out under the most severe operating conditions at the old Basin mill over a period of two years treatment of the Butte and Superior ores; that it was fully adapted in every detail to treat its normal tonnage of 1,200-tons daily, and to recover the maximum percentage of zinc mineral from the ores treated; and finally, that the original installation of the milling equipment was unreservedly approved by Manager Jackling.

Though the new concentrator was not permitted to operate, as outlined in an earlier issue of Mines and Methods, the new "Janneyized" plan of concentration which replaced the original installation now has been in operation for several months, with the result that to date the mill has not attained, either in point of tonnage treatment or average percentage recovery of zinc from the ores, the results obtained at the Basin concentrator which was operated under the most adverse circumstances.

LAST MONTH'S RECORD.

According to the company's operating record for last month 16,100 tons of ore averaging 1.015% lead, and 19.7% zinc were milled, from which there was recovered 5,154 tons of concentrate containing an average of 47.4% zinc. The percentage extraction is given at 76.85%. In this connection, however, the company's report is incorrect with reference to the ore tonnage treated, and the average percentage extraction. The correct tonnage treatment for the month was 18,716 tons of ore of the general average grade above mentioned, from which an average recovery of but 66.26% of the zinc mineral contained was effected. Further, it is now the customary practice at the property to follow the practice obtaining with reference to the Chino Copper Company, viz., the mining and subsequent shipment of high-grade ore from the enriched areas of the mines (which are limited in extent) direct to the smelteries. In the case of Butte and Superior the zinc content of the ore shipped direct ranges from 28% to 36.4% and the returns therefrom do not appear directly in the concentrator operation records, but through the distribution thereof in the monthly operating report, the account of zinc production from the mill is "doctored" so that the ultimate result is made to appear that the concentrator is effecting a much higher general average recovery of zinc mineral than really obtains.

A peculiar circumstance in the present operation of the new plan of ore treatment is the fact that, in order to treat an average of 675 tons of ore daily it is necessary to use the entire crushing and fine-grinding equipment of both mill units, each unit of which was planned with an equipment sufficient to care for the fine-grinding of 600-tons of ore daily under normal operating conditions. In other words, the crushing departments of both mill units are required to serve one concentrator unit. An idea of the highly efficient and economical milling treatment can best be judged from the information that four sets of 16x42-in. rolls, four 6-ft. chilian mills, two 8-ft. Hardinge mills, and six 4½x20-ft. tube mills comprise the equipment of the two mill units, and these are all in operation to handle the "increased" tonnage of 675 tons of ore daily. Primarily, the reason for this seems to be due to the fact that the "Janneyized" plan of concentration has proved inadequate, and rather than return to the established methods of concentrating the ore, the management has attempted to handle their entire ore tonnage through the flotation plant which originally was intended merely as a trap to catch the mineral not saved by the jigs. This recent "improvement" is an expensive one, and in part is reflected in the additional cost of treatment resulting from the high "mesh-penalty" charged by the zinc smelters, aside from the excessive cost of mill treatment.

In reference to Manager Jackling's statements that Butte and Superior will

earn a profit of $200,000 monthly on a treatment of 1,200 tons of ore daily, we need only refer to similar promises he has made relative to the earnings of the Utah Copper, Chino Copper, and others of which he is general manager, and then compare the actual results obtained from operations for 1912 therewith. As he states in the Boston News Bureau interview "stockholders should always have the 'DELAY' contingency in mind," and in this connection it would be well for stockhloders of Butte and Superior to bear in mind that the management will exercise a marked prerogative in its application, both in the matter of determining "just what rate of extraction will be the most economical" and in the payment of dividends.

Present operating conditions at Butte and Superior do not portend either the earning or paying of dividends for several years. To the contrary, and for reasons hereinafter set forth, it is quite probable that the public will shortly be asked to subscribe additional capital for the continuance of the experiments which are being carried out. At least there will be urgent need for an early disposition of the remaining 65,000 shares of treasury stock, or a consolidation with some other company, if operations are to be continued.

The financial situation of the company is perhaps best illustrated from a review of recent developments which are especially noteworthy and have considerable bearing upon the situation, both as regards the engineering talent of the new management, and the present financial position of the company. Following the assumption of the management by Mr. Jackling and associates negotiations were entered into with the owners of several groups of mining properties (including the Mastadon, Zeus, Snowflake, and others contiguous to the company's chief holdings) on the north and west with a view to their acquisition. Options were taken on the properties after what is supposed to have been a complete geological examination thereof by the Jackling interests (less than two days having been spent on the properties) and the first payment made thereon. The properties taken under option were considered by the management to contain valuable ore deposits, and subsequent payments were made thereon under the terms of the agreement, amounting in the aggregate to approximately $435,000. On March 6th., 1913, the payment due on the purchase price of the properties under the terms of the agreement was passed, and the option rights forfeited. This situation presents a very peculiar circumstance which can be explained in but two ways: That the company was unable financially to meet its obligations, and therefore was compelled to surrender the option rights, or, that the management, after having had the company expend $435,000 on the purchase of the properties, concluded that they were valueless—although there has been no development work performed on any of the properties to date to warrant the action taken.

The information given in the foregoing recital concerning actual conditions at the Montana end of the line should afford a means for stockholders to appraise the value of the stock which they hold in the company. However, to make the situation more lucid it is pertinent to make a general comparison of Butte and Superior operations with those of a well-known, well-managed, dividend-paying property.

Generally considered the market value of Butte and Superior stock at present is $30 per share on an issued capital of approximately 285,000 shares of stock having a $10 par value. The mining properties of the company contain, approximately, two million tons of zinc ore of a general average grade of 20% zinc, a tonnage sufficient to operate its 1,200-ton concentrator for a period of 4.65 years. No profit has yet been made from the property under its new management, and the probability of its entering the dividend-pay class is remote. Under honest, efficient and economical management, with a normal zinc market, the property might possibly earn $5,659,824.18 during its life, or $2,159,824.18 in excess of its entire amortized capitalization of $3,500,000.

On the other hand, as an illustration, the Miami Copper company, with an issued capital of approximately $3,712,875 on its par value basis of $5 per share, having at the lowest calculation 22,000,000 tons of 2% copper ore sufficient to operate its 3,000-ton concentrator for at least 25 years, and earning profits at the rate of $1,474,096 per annum, is given a market value of but $22 per share.

It will be noted, therefore, that Butte and Superior stock at present commands a market price of three times its par value, though it has not entered the dividend class, while the Miami stock commands a price of but four and two-fifths times its par value on a dividend-earning basis of approximately $1,500,000 per annum. There isn't anything that could be more ludicrous than the view which the sponsors of Butte and Superior would have the public take of the situation, nor how little attention the public really pays to actual mining matters. This is more pronounced when one considers that, even before the Butte and Superior concentrator was placed in operation the investing public purchased the stock, up to $52 per share, upon the advice of the promoters of the undertaking. There was nothing to warrant the high price reached by the stock, and there is not now any better reason for maintaining it at $30 per share, only that those who bought in at prices ranging from $40 to $50 can not sell—owing to the failure of the management to make good—and the controlling interests under the peculiar predicament in which they have placed themselves are now compelled to hold their stock till a plan is determined whereby they can again create an inflated market for their securities, and sell out on the rise.

"PORPHYRY" DIVIDEND FLUKES

No dividend from Ray Con.

No dividend from Chino Copper.

No EARNED dividend from Utah Copper.

No EARNED dividend from Nevada Consolidated.

These four paragraphs speak volumes for the real conditions under which the wildly boosted, "masterfully managed" low grade "porphyries" carried greetings to the confiding shareholders at the opening of the 1913 campaign.

It is claimed that Ray Consolidated earned $1,781,531 during the year 1912 and that Chino's earnings reached $2,352,822, or $2.83 a share on the outstanding stock. However, in the case of each, Mr. Charles Hayden, of Hayden, Stone & Co., "bankers for these two companies," declares that the failure to pay "was based purely and simply upon the fact that the boards of directors of these two companies do not propose to make the initial dividend one which is paid by borrowing money against copper.'

If Mr. Hayden's statement that there has been no market for copper for a long time is true and that dividends will not be declared until sufficient money has been secured through the sale of metal to provide funds, how has it been possible for the companies to figure earnings so closely as revealed in the figures given above? How do they know that Chino's earnings amounted to just $2.83 a share if the copper produced is still unsold? There is no question but what dividend payments should be deferred until there is money with which to cash the checks, and there is no legitimate kick coming against the directors for declining to take dividend action when they knew that the checks, if issued, would be marked "not sufficient funds" by the bankers What is true of

Chino, of course, is also true of Ray. But let that pass.

What the public and the investors in Ray and Chino shares would like to know is why did the company managements wait until the last minute to make known the fact that promises were not going to be lived up to; that the "underlying fundamentals of the copper market" were not as sound as so strenuously and persistently claimed? When these men laid awake nights to conjure up statements depicting what great earnings these companies were making and how easy it would be to pay two or three times as much as it was proposed to pay at the start, did not they know perfectly well that gross deception was being practiced? If not, they must be classed as dullards; if they did know and understand, why is the government overlooking them in its "get-rich-quick" prosecutions? If they knew that the copper produced by these mines was being held up so that the Utah Copper Company's product might be converted into cash; if they knew that the case of the latter company was so much more urgent than those of Chino and Ray—because Utah was already in the dividend list and making wilder claims than any of them—why did not that fact be given publicity? Why the apparent collusion?

Utah Copper, it would seem, had to be protected at all hazards; the money JUST HAD TO COME to meet its dividend requirements, because the claim of a huge surplus and constantly increasing dividend-earning power was being ascribed to it all the time—$6, $8 and even $12 a share might be expected from it this year—and to have been compelled to trim the usual quarterly payments from 75c. to 50c. or 25c., when $1.50 at least was logically expected, would have been calamitous. The showing was humiliating enough as it was. To close the last quarter of the year with a deficit and have its partner, Nevada Consolidated, make a similar exhibit, was certainly sufficient cause to bring about a state of nervous prostration in the Utah household—a state or condition so graphically illuminated in the reams of excuses and apologies reeled out by the publicity staff of the management—most of it at the dictation of "Managing Editor" Jackling.

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"NO SMOKING" PLEASE

If tobacco smoking were agreeable alike to those who smoke and those who do not, among men, women and children, the "No Smoking" sign would be obsolete; but the unique pleasure and comfort of tobacco smoking, personal and private as it is, has been carefully curbed by business and society everywhere, for the reason that some other person might dislike the odor.

Time was, in old New England, when tobacco was so common that the best men of society smoked it in the presence of ladies; yet those times are gone, and nowadays public opinion forbids it, when it interferes with the peace of another. One man's rights end abruptly where another's rights begin, is the edict of common sense.

At first, it was embarrassing to post a sign against a friend, or a business associate, asking that he refrain from the pleasure of a smoke while in our presence, and that he please retire to another room (or over into the next valley!) when he wished to start his "smudge;" yet gradually the greatest good to the greatest number has pretty generally been effected, and the smoker no longer expects to smoke indoors in public, except in certain, limited, secluded places; yet, he also knows he may smoke in the "smoker" without fear of giving offense to anyone.

However, should an occasional offender break the rule, any lady can ask him to desist, and feel that not only every bystander and every public attendant, is ready to support her and assist in pushing her request, but she can feel that the great heart of the community is back of her and that no fair thought anywhere is opposing her.

This is what "society," "business" or "public opinion" has done, and this is just what public opinion is doing for the large city that smokes. The smoking of the few, profitable and advantageous as it may appear to the owner of the smoking apparatus, is offensive to the many, and prohibition is being more and more effectually enforced everywhere.

Practically every large city in the United States has its smoke inspector, who is an engineer of several years' training, and who is supported by a corps of expert assistants. Smoke prevention is as plainly a part of city government as street grading or sewer laying, and is regarded as such in scores of cities; and when it becomes so in Salt Lake City, by the shaping of so-called public opinion, we will have smoke prevention laws, ordinances and departments as up-to-date and effective as Des Moines, Chicago, Cincinnati, Cleveland, New York, Pittsburgh, Washington, Boston, and every other fuel burning, but self-respecting city in the land.

Salt Lake City's present smoke ordinance provides that "it shall be unlawful * * * for smoke to be emitted or to issue from (certain boiler) chimneys," and the fine provided is from $5 to $50 for each offense. Yet, because of the lack of public approval—publicly and openly and plainly expressed—even this much smoke regulation cannot be satisfactorily enforced by a political servant of the aforesaid public. The repeated arresting of the city's business-men for letting their furnaces or smelters smoke in our faces does not yet meet public approval in Salt Lake City, and until it does receive moral support, as does a fine for trespassing, exceeding the automobile speed limit, etc., those charged with the duty of smoke abating will have a hard time and do poor work.

A government engineer in the U. S. Bureau of Mines, reporting on the success of smoke abatement work, says: "The most important conclusion reached is that smoke abatement by ordinance cannot hope to succeed unless supported by public sentiment. * * * The greatest advance has come in the past and must come in the future through the organized effort of the city smoke department, supplemented by the active cooperation of the citizens."

And when public sentiment supports and co-operates with, and encourages the smoke department, the inspector's work will become effectual. In a report on the eminently successful smoke prevention work in Chicago, it is stated that many causes contribute, "however, one of the principal contributing factors to the lessening of the smoke from the hand-fired plants has been the knowledge of the firemen that their stacks might at any time be watched by an assistant inspector."

After the support and encouragement of public opinion is given, without discrimination, and the smoke department feels that it can perform its duties without fear of disapproval (or perhaps dismissal) better laws and ordinances must be made and enforced.

Some of the provisions of smoke ordinances that other, much cleaner, though far larger cities, than Salt Lake City, have, and which we do not have at present are: A STATE LAW ENABLING THE CITY TO DEFEND ITSELF AGAINST LOCOMOTIVES, MANUFACTURERS, AND SMELTERS, LOCATED OR RUNNING OUTSIDE, BUT OFFENSIVELY NEAR THE CITY LIMITS. Wisconsin has such a law, and the ordinances in Denver, Colorado, are applicable to Denver county, which covers fifty-nine square miles. Locomotives have not been allowed on Manhatten Island (New York City) for several years; vessels in either the Hudson or East rivers must not emit smoke; neither may even an automobile smoke on lower Broadway.

"No Smoking" signs should be as

sacred to Salt Lake City in the way of fresh air commandments as to New York City, Milwaukee or Denver, and the sign should be on every furnace door in Salt Lake City and county, for exactly the same reason that it should be conspicuous in public waiting rooms for ladies.

Public sentiment is more powerful than law; it makes law, and public sentiment crystalized in, and led by, the Commercial Club, the city officials, and the newspapers, can not only encourage and enforce adequate smoke abatement measures in the city, but it can cause the removal from the valley of the smelters, which are the greatest offenders, and then make laws to keep them, and all other obnoxious plants, in a respectable condition, or out of reach of the nostrils of a clean city.

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FRENCHMEN TALK OUT IN MEETING

That the Frenchmen are "out of sorts" over the manner in which they have been bamboozled by the Butte and Superior promoters, is indicated in the following from the French financial journal, L'Argent, of February 7th:

"American journals inform us that although this enterprise (Butte and Superior) is still an experimental one, nevertheless an attempt has been made to place its shares with the small investor at a profit of 420%. Those who were imprudent enough to subscribe to them have already lost 91 francs per share.

"Early last November we were the first of the financial press to warn our readers of the new attempt made by the Butte and Superior Copper Company against the nation's small investors. We are glad for those who profited by that cry of alarm. Certainly things have happened to justify us beyond our expectations. The shares of $10 par, or 51½ francs, were, in effect, presented to (French) capitalists with a profit of 420%, or at 266 francs. Since that time AND IN SPITE OF THE EFFORTS OF THE PROMOTERS, the course of the price has been a PROGRESSIVE DESCENSION. Recently it tumbled to 175, or a brutal loss of 91 francs per share. Those who imprudently put coupons in the cog wheels swear—if somewhat late—that they will never again be caught.

"The introductory prospectuses mirrored the most brilliant perspectives of the future; and that was easy then because, up to the present, the enterprise has produced nothing. There is, nevertheless, one result of which no explanation is given, namely, the loss of sixty per cent undergone by the first (French) shareholders. The Company was founded in 1906 to explore for copper, as its name indicates, but by a curious and unexplained phenomenon, actual operations contemplated only the extraction of zinc. At the beginning the promoters mistook the kidneys of zinc for the glimmer of copper, (les vessies du zinc pour les lanternes du cuivre) or else they probably found themselves involved in the impossibility of treating the copper.

"Under these conditions we ask ourselves whether their new and later attempt will be more successful. Veins can exist from which no profitable extraction can be made. The reports received by us clearly indicate that the director, M. Jackling, also a director of Utah Copper and Chino Copper, has been compelled to put the valuation of his orebodies in the best light possible Meanwhile, with an unspeakable audacity, THEY EXTRACT GOLD FROM THE FRENCH FLEECE.

"That M. Jackling is not sure of the proposition, and is experimenting, is the impression gained from an interview in the Anaconda Standard, passages from which we are glad to be the first to give our readers. To the question of our confrere, the porphry magnate, (le magnat porphyrique), has responded: 'In the first place, although the new section of our mill has not been operating long enough to permit a definite judgment on the efficacy of our new process, still WE BELIEVE we have installed the true system, and WE BELIEVE, AFTER A TRIAL OF THREE DAYS, and COMPLETE INVESTIGATIONS which were made before the installation, that we have found the right method.' M. Jackling added that the new process had many points analagous to those employed in the treatment of the Utah Copper. A concentrating table replaces the jigs, and the system is a dry process instead of the usual wet process. * * * The section will treat 600 tons of ore every twenty-four hours, and with the other sections of the mill altered for the new process, the tonnage of the Butte and Superior will attain close to 1800 tons a day. The new process for the treatment of the refractory zinc ores is very satisfactory and advantageous Sections to the north and east of Butte are very rich in zinc, but up till this time it has been difficult to find a process of treatment, and attempts in this direction heretofore have been very expensive. We have all reason to BELIEVE that the difficulty has been surmounted.'

"As it is easy to imagine, we are far from this certitude, and on this subject the luxurious American magazine, Mines and Methods, directed by technicians whose competence is a guarantee of exactitude, makes judicious comment as follows: 'The assertions of Director Jackling on the subject of the merits of the new process ought not to be taken seriously either by speculators or by engineers. The replacement of jigs by tables, making of the system a DRY PROCESS INSTEAD OF THE USUAL WET PROCESS, does not indicate anything of importance, nor is there, furthermore, any sufficient explanation in the declaration: 'We have every reason to BELIEVE that the difficulty is surmounted.'

"The other operations of the Managing Director are no more precise and denote also a chance conviction. If we consider the charges continually reported in the Utah Copper, Ray Consolidated, and other mills directed by M. Jackling for the treatment of ores, with results equally sterile from the metallurgical and economic view-point, we may be excused for formulating the opinion that the Director was not very certain of himself when he told a reporter of the Anaconda Standard: 'We BELIEVE we are on the right track.' The views relative to future development were not any more precise.

"The journal, Mines and Methods, does not doubt the extent of the zinc orebodies of the region, but merely hesitates to believe that Butte and Superior has found a new method by which a marketable product can be made from the zinc ores But they point out that Senator Clark, one of the most skillful mine operators, has appealed to one of the most experienced metallurgical engineers to work out some process by which a profitable treatment can be made of ores on the dumps of his mines, which resemble the ores of the Butte and Superior. No result has as yet been obtained, even though the engineer did not ignore the methods employed by the Utah Copper, Ray Consolidated, and Nevada Consolidated.

"In order to be able to judge of the progress of the management of the Butte and Superior with a new 'dry process,' shareholders ought to demand the results of the diverse operations; they ought to inform themselves of the characteristics of the ore, of the elements that make the treatment difficult, of the quality of the product necessary to obtain the best market price, of the output of the mill sections before the changes were made, and the part played by the latest modifications. Stockholders ought not to be willing to declare themselves content with the reports declaring that so many tons of ore have been treated, and that so many thousands pounds of zinc have been extracted. Such indica-

tions will be absolutely insufficient when they relate to the zinc ores of the Butte region, which are known to be so rebellious.

"The promoters forget to give us these explanations. They are even in contradiction with Manager Jackling, who states that the mill will be able to treat 1800 tons of ore per day, while the introducing bankers only claim a maximum of 1500 tons per day. One could not take greater liberties with the public. It is necessary to have an unspeakable audacity to present the shares of such an enterprise to the public with a profit of 420%. It is necessary to count upon the unlimited credulity of the small investor to dare to capitalize at this price the illusions of a future completely uncertain, especially when they are still in an experimental stage. At all events, that the public ought not to allow itself to be taken in, the actual dimunition in price proves conclusively, and the attempt at placing the stock with French investors is a lamentable 'half-baked effort.'"

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STEAM SHOVELING BY FAITH

With the application of psychic forces to mining, we may expect some marvelous achievements that are now beyond the powers of the ordinary miner who depends upon brute force. A writer to the Times tells of attending a lecture by Benjamin Fay Mills, who recounted a remarkable story illustrating how a man might eventually move mountains by faith—no steam shovel or deferred stripping accounts required. Mr. Mills incidentally was unfolding a theory of psychology under the captain of "The Psychic Powers of Man." "Strange faiths are abroad in the world," the writer comments, "and I was not so much surprised at the wildness of Mr. Mills' theory as I was at the avidity with which the gathering of apparently intelligent men and women seized upon it. The address was made up of a smattering of the Bible, Emerson, Professor James, Frederic Myers, Christian Science, hypnotism, and some stories gathered from the four winds. As a proof of his belief that by faith a man could move mountains, Mr. Mills cited the following: "A workman was caught between the wheels of an immense stone crusher, which appeared about to mash him to a jelly, but the man, by means of the tremendous power of his will, gathered together within his frame such force that he was able to shatter the vast instrument of steel." Paraphrasing the words of Horatio: "There needs (a) ghost come from the grave to tell us this" ere we will believe it.—Engineering and Mining Journal.

All of which may be taken as a suggestion that Utah Copper might find an easy way out of abandoning its costly and inappropriate steam shovel methods and try an application of "faith" in removing the overburden from its "mountain of copper." The violent death rate among the miners employed also might be considerably lessened by application of "the tremendous will power" exhibited by the man who fell into the crusher jaws, above referred to.

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SOURCES OF POTASH

In connection with the search for potash in the West which is being made by the United States Geological Survey a great number of localities have been visited by the Survey geologists, especially in the Great Basin. Shally desert lake beds, so-called dry lakes or playas, are extensively distributed throughout this region. Most of these playas contain salts to a greater or less extent, and nearly all these salts show on analysis from 1 to 4 per cent or more of potash. Few of these lake beds show evidence of having ever been submerged to a considerable depth, and the deposits that lie in the lowest parts of most of them are probably only alternating strata of clays and saline muds, with thin salt crusts produced by periodic flooding and drying up. Large and massive deposits of crystaline salts can hardly be expected except as the result of the drying up of a very extensive and deep saline lake, or as representing the continuous accumulation of saline matter in a water body during a very long period of time. Record of the existence of such lakes in prehistoric times is to be found in certain parts of the Great Basin region. Contrary to the general assumption, however, the extensive lake basins are in fact relatively few. It is evident, therefore, that the search for the important salt bodies of this type has of necessity been narrowed to a relatively few localities.

The areas in Searles Lake, Panamint Valley, California, and the public land withdrawn from entry on account of their potash content are the lowest parts of two ancient lake basins, whose waters at their highest stage probably connected through a narrow strait. Both basins were filled by overflow from the drainage of Owens River and in both the salts are believed to have accumulated by natural concentration of the normal drainage waters from that source. The salt body in Searles Lake lies at the surface of the ground and was located in claims for the soda it contained, before interest in potash had been seriously awakened. The mud flat that forms the bottom of the Panamint Valley has recently been located in "potash" claims, but without any evidence that can be taken to indicate the existence there of a valuable saline mass. The salt that shows on the surface in the Panamint Valley is relatively insignificant in amount, and tests for potash in the surface salts or ground waters of this valley do not run higher than the average of such salts in mud flats and dry lakes generally. The lands have therefore been withdrawn on evidence of a more general character, the theory being that the former larger lake of the Panamint Valley when it dried up might have deposited a bed of salt as large as or larger than that now existing on the surface in Searles Lake. The Panamint Valley is relatively narrow, and the streams from the rugged mountain slopes that border it have spread their fans far into the center of the valley. Drilling, possibly to a considerable depth, will be needed to test the possibility of buried salt deposits in this valley, and if such deposits are found to be present, it is believed that they will be essentially like those of the Searles deposit.

Columbus Marsh, Nevada, is the evaporation pan of a shallow lake. Analysis of clays obtained in this deposit have shown some exceptionally high percentages of potash. No important beds of clear crystal salts have yet been found in the marsh, and the possible commercial value of such a deposit still remains a subject for further investigation Pending such work these lands also have been withdrawn from entry.

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They were discussing the market prospects of mining stocks in the Thornton hotel, Butte. "Now," said one of the party, "there are some good things yet left. Miami seems to be a good buy; Giroux is a good buy, and there are unquestionably other good buys; while its a cinch that it's GOODBYE to Butte & Superior."

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"Well informed insiders" gave out the tip a long while ago that a $1 dividend would be declared at the February meeting of the directors of the Chino Copper Co., and considerable stock was bought in anticipation of the initiation of a $4 annual rate. The meeting came and went, and all the outsider has now is the right to sell his stock a few dollars lower and wait until the "well informed" again prophesy dividends.—"By the Way" man in Engineering and Mining Journal, March 8.

ADDITIONAL FINDINGS OF FACT IN SMOKE TRAILER'S PATH

By J. CECIL ALTER.

In a three months' study of Salt Lake's winter smoke and fog problem, scores of little and medium sized facts have been brought to light (above the smoke) that really are no less interesting than the main disclosure, namely, the coincidence in the beginning of operations of the valley smelters, and tne one thousand per cent simultaneous increase in the number of foggy or smoky days, and the following notes are presented for the benefit of those who could not personally follow the smoke trails, wherever the interesting research might lead them, much as they may have desired to do so

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Clearer skies in summer are due to less coal smoke in Salt Lake City, to the absence of humidity as a more important cause, and to the greater wind velocities as a most important cause. The summer "smoke" is nearly all from the smelters, and shows distinctive color in the absence of the coal smoke and the moisture particles. The fewer rain storms to precipitate this smoke and wash the air clean in summer, are made up for by the stronger winds, which carry more of the smoke away.

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In weather folklore the adage says that when the smoke columns rise straight and very high, it is a sign of fair weather; and so it is, yet the cause of this rising of the smoke is the higher barometric or air pressure; yet this is the very condition under which Salt Lake City fogs are most numerous, persistent, and dense.

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When the barometer is high, the city smoke rises higher if not disturbed by winds of unsteady velocities or directions. This is because the denser air has greater lifting power, that is, it is more buoyant in its effect on the smoke. And here we may observe, that if the Salt Lake valley were at sea level, instead of three-quarters of a mile above, the air would average sufficiently dense to lift the smoke and smelter gases much higher above the city all the time

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CLEARING THE SKY.—A good rain storm usually clears the atmosphere very effectively. This is due to various causes, but mainly to the greater wind velocities accompanying storms than accompany fair weather; and to the "washing" of the atmosphere by the passage of the rain drops through it, which gather dust on the way down. A fresher, purer condition of the air also results from the combining of the sulphur-dioxide gas with the water that is on the way down; also, the rain drops carry down fresh uncontaminated air from aloft, forcing it to replace much of the lower air mechanically; and thus we get an invigorating freshness of air after a good rain.

A snow storm brings none of these clarifying influences but the wind, to any important extent; the velocities of the falling snow flakes are too slow to bring down the fresh air, or to capture and

IN A FIFTEEN MILE WIND FROM ANY DIRECTION THE CITY IS REALLY CLEAR, AS IT WOULD BE IN A CALM, IF SMOKE CONDITIONS WERE HANDLED.

force to earth nearly so many dust particles. Morover the annexing of the sulphur dioxide gas by snow is probably very limited.

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Farmers residing near Murray say that when the smelter smoke is blowing groundward so that one is forced to breathe it, the fumes are very oppressive and painful, because of the sulphur dioxide gas. An expert for the farmers says that about ninety-five per cent of the sulphur in the smelter smoke is sulphur dioxide.

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THE WIND AND THE SMOKE.—Notes made while making observations from various places around the city show some interesting facts on the relation of the wind to our smokes or fogs.

A northeast wind, as light as six miles per hour, will clean the city in thirty minutes.

After light southerly winds have been blowing several hours, it requires a fifteen miles per hour southwest wind, or a twenty miles per hour south wind to clear the city in thirty minutes, and it sometimes takes even longer.

A light wind ranging from two to four miles per hour for several hours from the south or southeast or southwest has filled the city and obscured the sky.

Smoke or fog is never recorded in a northwest wind of any appreciable movement.

Studious comparisons of the trend of the smoke trails over various parts of the valley with the wind vane records of the U. S. Weather Bureau, show them to be very similar, though sometimes a southwest wind at Midvale will become a southeast wind in Salt Lake City, by glancing from the mountains; or in very light winds which show the lack of a general sweep across the valley.

A fourteen mile southeast wind kept the city clean and blew the smoke out over the Great Salt Lake flats (January.)

January 9, 1913: A thirteen miles per hour wind from the southeast blew from 8 a. m. to 9 a. m., and at 9 o'clock the city was clear, except in the extreme northwest portion, where the smoke cloud had accumulated. The wind at the Murray smelter was southwest and calculating the velocity by comparing the flatness of the smoke trails with the smoke trails in the city, it was probably blowing about the same velocity as in Salt Lake City, or about twelve miles per hour. An opaque fan of smoke ran from the smelter northeast to Westminster Heights, growing thinner, toward the Heights, though even there, the college and other buildings were barely visible from the Boston building; the vertical depth was about half the apparent height of the mountains; the top surface was well defined, and the entire depth of the layer was of about uniform capacity from top to bottom, judging by the color.

An alleged clear day, looking north through Main Street from the Boston building. This is a view taken from the same point as that disclosed in the large clear picture.

Later in the day, after one and one-half hours of a more southerly wind, the smelter smoke spread or veered and extended in an apparently straight line from the smelter to Popperton and Federal Heights; at this time the view was gray at Eighth or Tenth East streets, as viewed from the Boston building roof. Most of the south end of the valley was behind the gray haze, but all this morning from 8:00 a. m. to noon, a twelve to fourteen miles per hour wind from the southeast over the down town portion of the city, (and the Weather Bureau windvane) kept the city perfectly clear of smoke

Judging by the way the smoke lies, as it leaves the chimneys along the Jordan river, and over the business section of the city, it is quite probable that both northwest and southeast winds are of higher velocities on the extreme western edge of the city, and along the center of the valley, than in Salt Lake City.

In a three mile per hour south wind (after the lapse of an hour, in which just three miles of wind were recorded) buildings six or seven blocks away from the Boston building roof were scarcely visible; the sky was blue, showing the obstructing smoke to be thin and low, though it was everywhere obstructing the view about equally in all directions. And when viewed from the tower on the Boston building roof, one hundred and ninety feet from the street, the haze or smoke was seen to be just as dense and as continuous at and beyond the city limits to the south toward the smelter, and beyond the range of the city smoke stacks. The Murray and Midvale smelter stacks were not visible.

The smoke stacks at the Midvale smelters are nearly always visible when the "fog" is not enveloping Salt Lake City, but when ten miles of wind from the northwest blew in an hour, the south end of the valley had clogged so full of smoke that the stacks were not in sight. The entire valley north of a line east and west through Murray was crystal clear. The Midvale stacks are twelve miles away; when this ten miles per hour wind had continued three hours longer, the Midvale stacks were just visible against the gray smoke bank.

Very little smoke has been seen to pass out of the valley to the south even in a good northerly wind. The gorge affording exit to the railroad at the Jordan Narrows is about 4,600 feet above sea level, or 350 feet above the railroad stations in Salt Lake City. However, the general wind routes over the Narrows is about 5,000 feet above sea level, or practically the elevation of Fort Douglas. Since the smelter and city smoke usually hangs within 750 feet of the ground, after it has been cooled a short time, it will be seen that very little of it can be forced out of the Jordan Narrows, for the top of the smoke level averages just about the same elevation as the mountain ridge, through which the Jordan river breaks on its way to the Salt Lake valley.

In a fifteen to eighteen mile northwest wind over the city, maintaining a perfectly clear view over practically the entire valley, Stansbury Island, in Great Salt Lake, is often invisible, and it would seem that the smoke or haze has been becalmed, or blocked north of the Oquirrh mountains. This occurs only after a long and fairly brisk southeasterly wind, which

which carries the smoke out toward the lake. Under all ordinary circumstances, Stansbury Island is plainly visible from the city, though it is nearly twenty-five miles away.

A twelve mile wind from the north sags the smelter haze in a pretty curve from the north end of the Oquirrh mountains through Murray, or sometimes Midvale, and up along the Wasatch mountains to Westminster Heights, or thereabouts; the Midvale smelter stacks feeding the smoke bank to the south were faintly visible during this wind.

A northwest wind of fifteen miles per hour followed by an eighteen mile wind the next hour, left the black Midvale stacks rising naked into the clear air, revealing the full view of the ridge at Jordan Narrows, a very rare occurrence. A faint gray haze appeared, unmistakably, beyond the Narrows, indicating that our smoke had been driven into Utah valley. The Oquirrh mountains were invisible throughout because of the remnant of smoke not caught by the northwest wind.

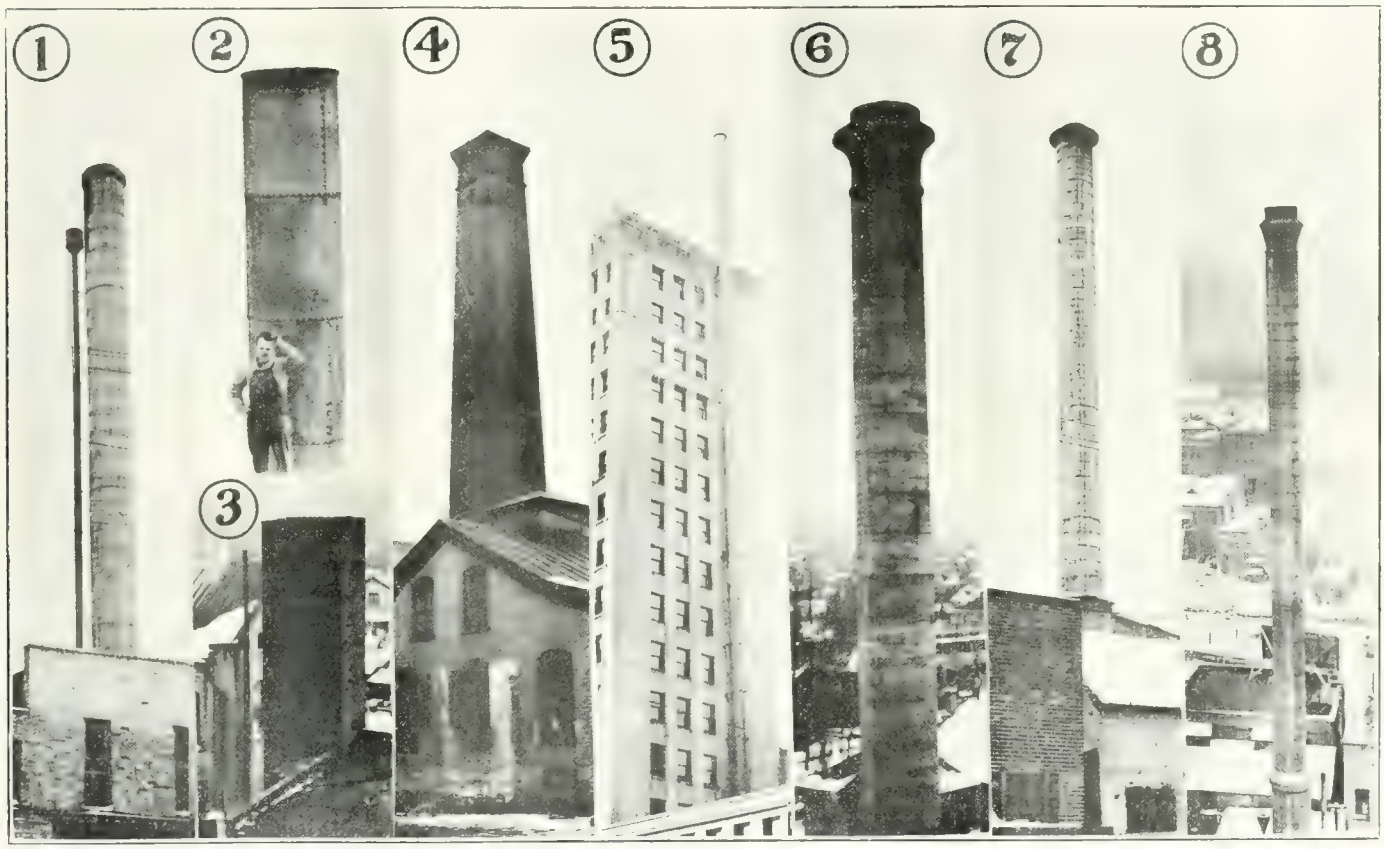
* * * *

CITY FURNACES NOT TO BLAME.—Professor E. H. Beckstrand, of the Mechanical Engineering Department of the University of Utah, says there are forty tons of unconsumed carbon and other substances thrown into Salt Lake's atmosphere daily. This estimate, he says, is 2 per cent of the total coal consumed, while in London the smoke is as much as 6 per cent of the coal.

If forty tons is 2 per cent, then 100 per cent of the coal used in Salt Lake City is approximately 2,000 tons a day. It has already been shown in these columns that 80 per cent of this daily consumption of coal is used in the residence section, and 20 per cent in the business section and in the railroad yards. Therefore, the amount consumed in the business district and railroad yards is 400 tons daily. A careful canvass has been made in the down town districts, and the interesting facts disclosed that 132 tons of this daily consumption of 400 tons is burned in furnaces which are fed by mechanical stokers and which do not emit smoke more than an hour or so a day. Moreover, the smoke that does come out when the grates are being cleaned is very thin and light compared with even residence smoke.

As a general rule, the mechanically-fed furnace smokes a little about five times in twenty-four hours, and each time for from three to ten minutes, while the grates are being cleaned.

Nine heating plants supply heat and power, and in most cases lights, for sixty of the city's largest buildings down town, and consume 132 tons of slack coal daily, as a winter average, and with practically no smoke. This tonnage is exactly one-third the total amount used in the business district. It will therefore be seen that attention must be diverted from most of the large down town smoke stacks and directed to those large stacks



THESE PICTURES WERE TAKEN DURING THE PAST FEW WEEKS AS WEATHER CONDITIONS PERMITTED, TO SHOW HOW WELL REGULATED PLANTS BEHAVE.

(1) The Tribune heating plant stack; supplies heat, light and power for the Tribune, Herald and Kerns buildings and uses six tons of coal per day. **(2)** Newhouse furnace stack; heats Commercial Club, Mining Stock Exchange, Boston and Newhouse buildings, using twelve tons of coal daily. **(3)** The Dooly block, old Commercial Club buildings and stores, Mine & Smelter Co., Armory building, Smith-Bailey Drug Co. and Fairbanks-Morse Co. Burns ten tons of coal daily in winter; mechanical stokers. **(4)** The Z. C. M. I. plant; heats Z. C. M. I. stores and factory and the Empress theatre; consumes thirteen tons of coal daily. **(5)** The Walker Bank building stack; smokes a little twice a day; furnace burns ten and one-half tons of slack coal a day in winter; fed by automatic stoker. **(6)** The Bransford stack; serves the Brunstead and Emery flats and uses two and one-half tons of coal a day. **(7)** Utah Hotel, or Church heating plant; heats all buildings and gymnasium, Bishops' building, Utah Hotel, Beehive and Lion houses, Templeton building, Deseret News building, Vermont and Sharon buildings, and Miller flats. Uses Green chain grate and fifty-five tons of coal daily in winter. **(8)** The cement stack here shown serves the plant which heats the Judge building, Felt building, six stores on Main street south of Judge building, Colonial theatre and Masson theatre buildings, and burns six tons of coal a day. Beyond this and a little to the left are located the stacks (not shown in picture) that serve the furnaces which heat the present Auerbach store, Linden hotel, Keith-O'Brien store, Brooks' Arcade and all stores west to alley at Freed's. These furnaces consume seven and one-half tons of coal per day and are equipped with mechanical stokers.

in the valley which have no smoke consumers and which never cease their smoking, from night to day, nor from summer to winter, as is the case with the smelters.

* * * *

WATCHING THE SMOKE.—Benjamin Franklin once said that religion is like a fog. Every religious believer is perfectly sure that where he stands is the region of greatest light and that the other fellow is in a much denser atmosphere. This is also true of the smoke problem, if the observer has only limited time and opportunity to make his observations

One man says a certain stack is "always pouring out black smoke" yet there has been watchers put on that very stack, and actual observations show that the stack smokes less than fifty minutes out of the twenty-four hours; but it smokes at regular intervals, while the grates are being cleaned, and these instances coincide exactly with the time our critical observer was on the way to or from his usual work.

Another observer insists he sees the smoke go up from a great stack and that it comes down on all sides and envelops that particular region of the town; yet a careful watch of this, and other stacks, shows that the surface fog or smoke was flowing very slowly across the town and that the smoke from the big stack in question was actually forced by its own great draught and intense heat to rise several hundred feet in an unbroken column above the general layer of fog or smoke and blow away.

It is for this reason the many downtown stacks are wrongfully accused of being the source of the trouble; the observer is like the man in the fog and sees only what is closest to him. The man above the fog, or at some distance away from it sees that all parts of the city are equally enveloped with it; and every one of the scores of careful thinkers and studious men who have driven to the slopes of the mountains or out into the valley early in the morning for a few hours to examine the fog or smoke formation, have been convinced that the smoke problem would be practically the same if every large heating plant in town were left cold all winter.

Looking northeast from the Boston building tower on a fourteen mile west wind. A really clear city and the mountains in full view from down town, as is rarely sight of late.

* * * *

ORIGIN OF THE SMOKE.—What is smoke? "The gases of hydro-carbons, raised to a red heat or thereabouts, without a mixture of air enough to produce combustion, disengage their carbon in a fine powder, forming smoke The disengaged carbon when deposited on solid bodies is soot," says an authority. Automatic stokers (endless belt-like chain grates, or screw or worm feeders) are so arranged that the disengaged carbon is not only mixed with ample quantities of air to provide the necessary oxygen for complete combustion or total consumption by the fire, but this draught carries the smoke over a broad bed of white burning coal to enforce the annihilation of the visible smoke. In a perfect or smokeless burning there go up the chimney the water vapor, carbonic acid gas, nitrogen and sulphurous acid.

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WHERE THE SMOKE GOES.—Some one asks "where does the smelter and city smoke finally go?" Most of the smelter smoke "dies" in the valley; if there is a northerly wind of good velocity of several hours duration, the smelter smoke trails have been traced through the Jordan Narrows, though as a rule very little of it gets out of the valley in that direction, so far as observations show. This is due primarily to the relatively great specific gravity of the smoke when cooled; it rises pretty well from the stack, in quiet conditions under the impulse of the intense heat, yet it is not in the air more than two hours and usually gets no more than ten or fifteen miles away from the stack till it has settled to the earth and appears as a ground smoke of from fifty to two hundred feet in depth; it also diffuses horizontally, fairly well, so that large regions have about the same texture of smoke covering at any one time.

Also looking northeast from Boston building tower on a so-called clear day, that is, no clouds in the sky and surface views unobstructed within half mile.

The nearer the earth the layer comes, the slower it settles, on account of the greater density of the supporting air, and the diminished rate of cooling so far re-

moved from the stacks. In quiet air the smoke has been observed to become very much attenuated in a few hours, indicating that much of its solids have been permitted to settle to earth. When there is considerable wind there is sufficient vertical component of air motion to keep much of the smoke from settling as soon as it would otherwise; but under any circumstances if the smoke remains in the valley, its heavier particles are constantly settling to earth.

Looking southeast from Boston building tower in a dense fog or smoke. City and County building tower showing above fog or smoke. Taken last month about 9:30 a. m.

However, the sulphur dioxide gas, which forms a very large proportion of the smoke from the smelters, does not settle to earth; it is heavy enough to remain in the lower air strata and to require a gale to force it out of the valley, yet the supply in the air is not appreciably depleted by accumulations on the grounds in low places, ditches, etc. This is because of its great quality of diffusion, acting in opposition to its density.

Once in a long time, a long-sustained southerly wind will force much of the valley accumulations of smelter smoke out of the valley to the northwest, though clarification from this source is so rare as to be of little importance.

As for the blacker city smoke, a southerly or easterly wind will blow much of it easily out of the valley; it is more easily carried by a light wind than is the cool low-lying smelter smoke at this distance from its place of origin. However, with continued southerly winds during the coldest part of the day, when the most coal is consumed, the residence smoke flows over the business section and gradually drops its sooty flakes on the way. It is probable that at least 85 or 90 per cent of the total smoke in the valley never gets out, but remains to clog the air, or ultimately settles to earth.

Coal smoke is not "a lighter-than-air gas which may rise aloft and float away," but is composed of material particles, which are continually seeking the earth under the impulse of gravity. It is estimated that 90 or 95 per cent of the visible smelter smoke manufactured in the valley never gets away, and that 60 to 80 per cent of the city smoke never gets out of this part of the Salt Lake valley.

Taken same day as dense fog photo, about 3 p. m. A "clear" sky and a "clean" city, as usually observed in these latter days.

SAMPLING THE AIR.—The Commercial Club Smoke Investigating Committee received the suggestion that samples of the air and the smoke be taken to determine the contents and thus arrive at the "probable" cause of the trouble. This brings to mind the sampling work done by an alleged expert here this past winter. He worked several weeks and succeeded in securing over forty samples of air at various places in the valley, in bottles having a capacity of a few cubic inches, and in other small containers. In only two of these samples was there more than a suggestion of sulphur, and in these there was only a trace

Indeed he could not have found more, for a "trace" of sulphuric acid in so small a sample of air is a very full charge of the poison. In fact the total amount possible in an entire cubic foot of air (which is probably several times the amount of air collected in all the forty odd samples taken) could not exceed what the chemist calls a "trace" or the air would be a veritable draught of pure poison into the lungs.

Of course in a small sample of air, fully charged with sulphuric acid, etc., from the smelters, the analyzer must report a trace. Therefore we add to the suggestion to the Smoke Committee that if tests be made, that they be made of at least as much air in one sample as one would breathe in an hour, or enough to actually determine the facts as they may concern the welfare of human beings.

SHARE OF SMELTER SMOKE.—Estimates of the proportion of smelter smoke, residence smoke, and furnace smoke, existing in the business district at one time have been made by watching all the fields of smoke from their inception before sunrise till toward noon, from various nearby mountain eminences and from the Boston building tower. In average quiet conditions with very light southeasterly winds, in January, the obstruction was probably one-fourth smelter smoke, one-fourth furnace smoke, and one-half house smoke; in a six to ten

miles per hour south wind, the accumulation changes to from one-third to one-half smelter smoke, which is always distinguished by its color, and the rest residence and furnace smoke, the latter remaining at most no more than one-half the residence production, which is flowing across the business district; mixtures of this kind have prevailed for an hour or so perfectly dense down town, but without the excessive formation of true fog as shown by the streaking or commingling of the various kinds of smoke. Again, moist fog has exerted its strong influence by binding the smoke mass into a more homogeneous and immobile mass; a fact that has been plainly observed from the hills

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SEEN FROM ENSIGN PEAK.—One morning's observations from Ensign Peak, beginning at daylight, are here given: The valley was observed to be nearly clear of smoke at first, but several large chimneys in the business section were issuing isolated columns of very black smoke. The city's smoke cloud had not yet formed, and, when it did form, it was not continuous at first.

At 7:30 a. m., just as day was breaking, the lower ground levels of the valley contained a bluish haze of the same color, but of thinner texture, as was hanging low in the extreme south end of the valley. The smoke fan, spreading out from the smelters, broadened rapidly. By 7:45 a. m., (late December, 1912), the residences in the lower eastern portion of the city began their smoking conspicuously, and soon a low continuous smoke layer was flowing westward and joining the isolated streams of denser down-town smoke

The house smoke was lower, more continuous, grayer in color, and was apparently confined to the city below the east benches. The northwest portion of the city was clear at 8:30 a. m., apparently because the westerly drift of the general smoke layer had no northerly component up to that time. From about 7:50 a. m. to 8:20 a. m., the streets down town were closed by the dense smoke; a very light northeast breeze from the bench, against the easterly or southeasterly trend across the city, kept the streets and blocks north of South Temple street clear, so that Utah hotel, the Bransford apartments, and other nearby buildings, were in sight from the peak, showing up against a dark bank of smoke clouds. The density of all smoke seemed to diminish about 8:30 a. m.

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SMOKE INFLUENCE ON CLIMATE.—Julius Hann, the world-renowned meteorologist at Vienna, says the temperatures recorded in large cities, even where the instruments are properly exposed, far above the influence of reflected or contact heat, are from 0.9 deg. to 1.8 deg. F. too high; that is, higher than would be recorded in that identical place if the city were removed.

This is due in part to the heat from the buildings, part of which originates within the buildings and part from the sun; but it is due mainly to the "smudge" blanket of smoke which usually dissipates enough in the day time to allow maximum temperature to reach a natural or unobstructed value, but which at night or early morning at the coldest part of the twenty-four hours, when all fires are getting started, serves to prevent the natural or normal loss of heat from the earth by radiation.

A century or more of official weather records show Paris, France, city temperatures to be 1.4 deg. F. too high, or above the values from similarly exposed instruments in the adjacent countryside. The regularly published mean annual temperatures of Vienna, Austria, are 0.9 deg F. too high and Berlin, Germany, records are also 0.9 deg. F. too high. All these are very large cities, and doubtless have a large city's share of smoke.

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SULPHURIC ACID MAKERS.—When the pathological division of the U. S. Bureau of Animal Industry reported that the death of the millions of ducks in the Great Salt Lake marshes was due to "sulphuric acid," the newspaper reporter who handled the story in New York said the acid came from "certain industrial plants," as if they might have been "potato crushers," or "orange sweaters."

As a matter of fact, what the examining doctor did surmise was that the poison came from the beet factories and fruit and vegetable canneries. However, in 1910, the State Fish and Game Commissioner noted that the poison from these plants was killing the fish in the nearby streams and at that time he required all these factories to filter their refuse and waste water before letting it into the streams. Large filtering tanks or pools several yards in extent perform this service quite satisfactorily so that no poison of any sort reaches the streams. The only other sulphuric acid makers of importance in the state, are the smelters.

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A prominent assayer of this city estimates that there are ten cars, of forty-five tons each, of sulphuric acid wasted in the valley every day that might be used.

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There would probably be no sulphuric acid problem to consider if the smelters were away, despite the ever-present quantities in coal smoke; as, with prevailing southeasterly wind, this sulphuric acid of the city smoke like the smoke itself, would be passing continually away from the city, and not accumulating like that which comes over the city broadcast from the south, and reaches parts of the benches and the city where no city smoke could ever reach.

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FREE SULPHUR—In several places in the United States sulphur dioxide is manufactured and sold to folks who are in need of it, and who buy it when they want it, but in the Salt Lake valley, the residents have it forced on them day and night.

The gas is used largely for disinfecting purposes—for instance, in a sick room. It would, therefore, seem that Salt Lake City is pretty well disinfected by the dearly-bought disinfectant. Since the smelters came to the valley, the vital statistics of Salt Lake City show a marked decrease in the proportion of, and number of, victims of contagious diseases; and while city physicians claim this to be due to their efforts in various ways, it seems appropriate, at least, to mention the disinfecting performed by the smelters in connection with the decrease of contagion. In this respect it takes the place of some of the sunshine which it obstructs, the city being well fume-gated."

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SOME DATES—The Hanauer and the Germania smelters were built in the neighborhood of Midvale in 1871 and 1873. The Highland Boy at Murray ran from May, 1898, to Janaury, 1908, the American Smelting Refining Company's plant at Murray began operations in 1902 and is still running. The United States Mining & Smelting Company's plant at Midvale began operations October 1, 1902; and the Garfield plant started its various units at various times in 1907, and all are still operating.

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OBSERVATIONS FROM GRANGER.—Avery beautiful picture is seen from the Granger or Hunter Bench, fifteen miles southwest of the city, on all moonlight nights when fog or smoke has accumulated over the city. The city lights and the moon serve to illumine the smoke, and a beautiful glow is the result, which lasts while the smoke is continuous over any extensive region. This phenomenon results from the same principle that renders a ray of sunlight visible across a darkened room. The tops of the Wasatch mountains are always visible above the smoke from a Granger elevation, which is about the same as the Utah Hotel bee-hive.

WASHOE SYSTEM OF INDIRECT CLASSIFICATION

By AN OCCASIONAL CONTRIBUTOR.

Pursuant to its policy of advancement in the arts of mining, milling, and metallurgy, the management of the Washoe concentrator at Anaconda, Montana, recently has completed important changes in the manner of milling the low-grade copper ores from its Butte mines. The principal object in view has been to increase the concentrator mill unit normal capacity, and, incidentally, to effect a higher general average recovery of the copper minerals contained in the ore treated. The results obtained from the changes to be hereinafter outlined have proved eminently satisfactory, and the entire mill flow-sheet will be rearranged according to the proposed plan of concentrating which has been in operation in Section 1 for several months.

Primarily the plan of concentration installed in Section 1 of the Washoe concentrator considers closer classification of the material treated by means of an indirect system of classifification. In the application of the indirect system advantage is taken of the almost complete elimination of slime at each successive sizing operation and the arrangement of the classifiefirs in a manner that will permit the elimination of slime from the resultant product of the rolls, mills, etc., during the different stages of crushing. Further, the plan of indirect classification as at present employed is not unlike other systems of direct classifying, as in the case of the Richards and others of the same general type.

The ultimate result is in both instances, however, the same, or nearly so. The marked advantage of the indirect system lies in the fact that, in lieu of attempting the close classification of pulp during a single operation advantage is taken of the elimination of slime at successive crushing stages as hereinbefore mentioned, and the remaining material subjected to but a simple separation of fines from sands which products are in turn treated on machines best adapted to the treatment thereof. Through a gradual elimination of the free mineral contained in the pulp the resultant middling is subjected to the necessary regrinding and by a system of progressive classification the various sizes (other than slime) of material are transferred from one series of classifiers to others, either directly or indirectly, but generally following the preliminary treatment on jigs or tables This will be more clearly outlined in a later paragraph covering the mill flow-sheet.

The classfiers used in the Section 1 of the Washoe concentrator are of the single unit, double-cone, hydraulic type, commonly termed the B. & M.—Boston & Montana—classifier. But two products are made, an overflow and a spigot discharge. Dependent upon the grade of pulp, these products are each in turn treated on separate machines, or at least one product delivered to a secondary classifier for further treatment.

FEATURES OF THE FLOW SHEET.

From the receiving bins the mine-run ore is passed over two 2-in. round hole shaking screens, the undersize going direct to two No. 1 bucket elevators, and the oversize passing through a 12x24 Blake crusher reducing the material to approximately 2-in. ring, then over two 2-in. trommels the undersize from which goes to the No. 1 elevators. The oversize from the 2-in. trommels passes through two 5x15 Blake crushers, reducing to approximately a 2-in. ring, the crushed material then going to the No. 1 elevators.

The two No. 1 bucket elevators deliver the 0 to 2-in. material to four 1-in. trommels, the undersize therefrom passing onto four 10-mm. trommels, and the undersize from the latter in turn going to a series of eight 4-mm. trommels.

The oversize from the four 1-in. trommels (approximately 1-in. to 2-in. material) serves two Harz jigs, and the oversize from the 10-mm. trommels (approximately .4-in. to 1-in. material) serves a group of four Harz jigs. This series of six coarse jigs produces a coarse cup concentrate which goes to the blast furnace concentrate bin. The 1 to 2-in. middling from the two first coarse jigs is passed through one set of 24x54 Anaconda type rolls set to crush to ¾ inch ring, and the .4-in. to 1-in. middling from the four last coarse jigs is passed through a separate set of 24x54 Anaconda type rolls set to reduce to approximately .5-in. The roll crushed product is returned to the two No. 1 elevators in closed circuit, the outlet from which is the minus 10-mm trommel or the ¼ to 5-16-in. Harz jig sieves. The Harz jig hutch product, together with the oversize from the series of eight 4-min. trommels, is treated on two coarse feed Hancock jigs, and the 4-mm. trommel undersize is delivered to a group of five No. 1 B. & M. double cone hydraulic classifiers.

The two coarse feed Hancock jigs produce a concentrate which goes to the 3/8-in. concentrate tanks for dewatering; a return middling which is retreated, and a middling-tailing which, after dewatering in one V middling tank, the plug discharge thereof passes the pulp through one set of 15x42 intermediate rolls reducing to approximately 4-mm., thence to two No. 2 elevators to six 4-mm. trommels, the oversize from the latter being returned to the intermediate rolls in closed circuit, and the trommel undersize passing into the five No. 1 B. & M. classifiers.

THE B. & M. CLASSIFIERS.

The No. 1 B. & M. classifiers make two products, an overflow (approximately 0 to .08-mm.) that goes to the total classifier overflow tanks, and a plug discharge (approximately .08-mm. to 4-mm) that passes directly into six No. 3 B. & M. classifiers, the latter producing an overflow (approximately .08-mm. to .75-mm.) which passes into three No. 4 B. & M. classifiers and plug discharge (.75-mm to 4.0-mm.) which serves three fine feed Hancock jigs. These jigs make a fine concentrate which is delivered to one No. 4 elevator, thence to No. 8 elevator serving the fine concentrate bins; a return middling which is retreated on the jigs, and a middling-tailing which, after dewatering in a V tank is delivered to two No. 3 elevators serving eight 1¼x12-mm. trommels, the oversize from which passes through two sets of 15x42 finishing rolls, and returned to No. 3 elevator in closed circuit with the trommels mentioned. The undersize from the 1¼x12-mm trommels delivers to a group of ten No. 5 B. & M. classifiers, the overflow product therefrom (approximately 0 to .08-mm.) going to the total classifier overflow tanks, and the spigot discharge (approximately .08 to 1.25-mm.) going to eight No. 6 B. & M. classifiers, the overflow product from the latter (.08 to 75-mm.) to seven V dewatering tanks, and the spigot discharge (approximately .75 to 1.25-mm.) to a group of nine Wilfley roughing tables. These roughing tables produce a clean concentrate which is returned to No. 8 elevator to concentrate bins; a rough concentrate which is returned to No. 6 elevator and there-

from to the No. 3 classifiers, and a middling-tailing which goes to No. 5 elevator to four No. 7 B. & M. classifiers, the last mentioned producing a middling and a tailing. The tailing after dewatering enters the tail race, and the middling passes through four 6-ft. Huntington mills reducing the pulp to approximately .75-mm., then to elevator No. 3 in closed circuit with the 1¼ 12-mm. trommels. The overflow product from the No. 6 classifiers (.08 to .75-mm.) serving the seven V settling tanks above mentioned is subjected to the following treatment: An overflow from the seven V classifier-settling tanks is delivered to the general slime pond, and two separate plug discharges of the thickened pulp serve individual groups of a series of thirty-two secondary Wilfley tables. These tables produce a concentrate which is sent to the fine concentrate bins via No. 8 elevator; a middling which by elevators No. 7 and No. 6 is delivered to the No. 3 classifiers.

The overflow from the No. 3 classifiers into the No. 4 classifiers is followed by an overflow from the latter classifiers (.08 to .35-mm.) into nine V dewatering tanks, and a plug discharge (approximately .35 to .75-mm.) to a group of ten coarse primary Wilfley tables, which produce a concentrate which goes to concentrate elevator No. 8; a middling that is returned to the No. 3 classifiers through elevators No. 7 and No. 6, and a tailing that enters the race. The overflow from the nine V dewatering tanks goes to the slime pond, and the two separate plug discharges serve twelve fine primary Wilfley tables, the latter producing a concentrate which goes to No. 8 elevator serving the fine concentrate bins; a middling which is returned to the No. 3 classifiers through elevators No. 7 and No. 6, and a tailing which enters the tail race.

The product of the total overflow of the No. 3 and No. 5 classifiefirs goes to a series of twenty Callow cones, the overflow from which enters the total slime tanks, and the plug discharge is delivered to twenty-four fine sand Wilfley tables. The headwater from these tables enters the total slime tanks; a fine concentrate is produced and sent to the fine concentrate bins; a tailing enters the race, and a middling is produced which is retreated on this group of tables together with the new pulp.

The total slime tanks serve twenty-four Callow cones, the overflow therefrom entering the tail race, and the plug discharge going to eight four-deck cement-floor buddles. The buddles produce a concentrate, a middling which is returned for retreatment, and a tailing. In this connection it is interesting to note that, during recent competitive tess of several well-known slime reating machines with the cement-deck round tables, the latter in every instance demonstrated their superiority, and will comprise the principal equipment in the slime treating plant which the company contemplates building.

From the flow-sheet outline given in the foregoing paragraphs it is particularly interesting to consider the classifying system independently of the remainder of the mill, and to more clearly point out the relation which each unit group of classifiers bears to the entire classifier series. For example, the No. 1 classifier considers the elimination through the overflow of the 0 to .08-mm. material from the 4-mm. trommel undersize feed and delivers the product to the Callow settling cones for dewatering, the plug discharge, .08 to 4.0-mm. product, going directly to the No. 3 classifiers. The No. 3 classifiers in turn make an overflow product, .08 to .75-mm., that serves as the feed for the No. 4 classifiers, and a plug discharge, .75 to 4.0-mm., which is treated on the fine Hancock jigs. The No. 4 classifiers produce a .08 to .35-mm. overflow feed which, after dewatering, is treated on a group of fine primary Wilfley tables, and a plug discharge, .35 to .75-mm. that is treated by a group of coarse primary Wilfleys. The middling plug discharge of the fine Hancock jigs passes to the 1.25x12-mm. trommels, the undersize therefrom entering the No. 5 classifiers. These classifiers make an overflow of 0 to .08 material that goes to the Callow cone settling tanks, and the plug discharge, .08 to 1.25-mm., serving as feed to the No. 6 classifiers, the latter classifiers in turn producing an .08 to .75-mm. overflow which, after dewatering, is treated on a group of secondary Wilfley tables, and the .75 to 1.25-mm. plug discharge treated by Wilfley roughing tables. The middling-tailing from the Wilfley roughing tables serves as feed to the No. 7 classifiers, the latter producing a tailing through overflow, and a middling through the plug discharge that goes to the Huntington mills for regrinding, thence to the No. 3 classifier.

It will be noted from the foregoing that, in point of general operation of the classifier series, the individual units consider indirect classification of their respective feed, but, in the aggregate, the series of individual groups of classifiers operate altogether as a direct system. Through the system of indirect classification the individual classifier units give a mixed feed to the fine jigs and tables from which the maximum of free mineral is removed, and the return product (middling) reground and again classified over a different circuit, dependent upon the particular requirement for the product. Slime is rejected at successive stages of classification, but generally through the No. 3 and No. 5 classifier overflow, and removed from the classifier circuit thereafter to be treated separately. This feature of the operations is desirable, and permits the delivery of a comparatively clean sand product to the several concentrating machines.

In general, comparing the operation of the B. & M. system of indirect classification to the direct system represented by the multi-pocket direct type classifiers (Richards-Janney, etc.,) the former has clearly demonstrated its superiority, both in metallurgical efficiency and cost of maintenance. Further, while there is no shortage of water at either the Great Falls or Washoe concentrators where the B. & M. classifier has found its most extensive application, actual operating conditions have indicated that the quantity of water required for the classifier hydraulic is far less than for the direct type machines. This feature is of particular interest inasmuch as it solves an important problem for mills in the arid regions where water for concentrating purposes is at a premium.

Section one of the Washoe concentrator has been rearranged in accordance with the flow-sheet plan hereinbefore outlined, and the remaining seven sections of the mill will be changed to conform therewith as rapidly as possible. Of course, it is to be expected that minor changes will be made from time to time, but the foregoing outline is representative of the general plan of treatment.

The new section is treating an average of 1,500 tons of ore daily of a general average grade of 2.5 to 3.3 per cent copper and effecting an average recovery of 85 per cent of the copper minerals contained in the ore treated. This is an increase of fifty per cent in tonnage over the average treatment of the other mill sections, and a higher comparative general average recovery of mineral.

———o———

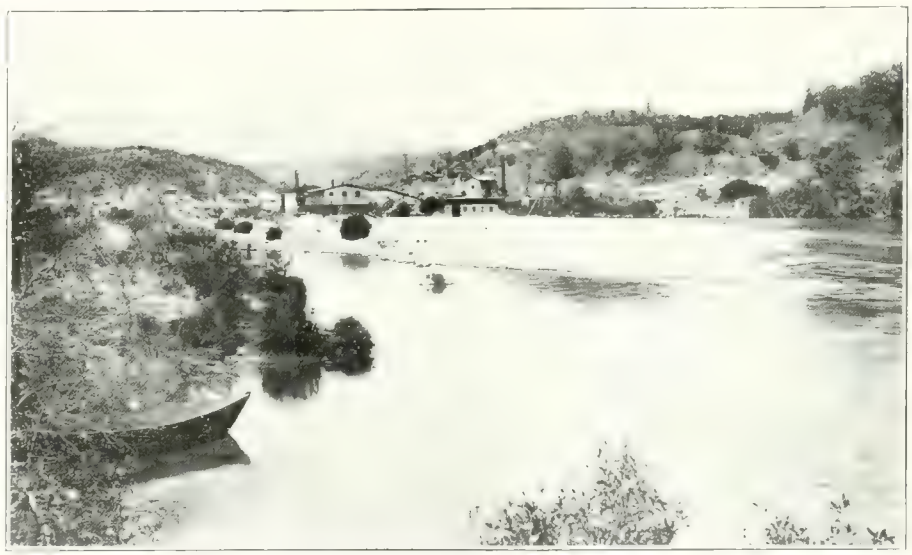
Chemically pure gold is prepared as follows: About 10 grams of gold in any form are dissolved in aqua regia and the solution is boiled to expel all free chlorine, diluted to about 10 litres and allowed to settle for about one week. The clear liquor is decanted upon a filter by means of a syphon so that the settled residue may not be disturbed. About two pounds of pure oxalic acid are dissolved in water and mixed with the gold solution and allowed to stand for a week, the clear solution decanted off, the gold precipitate washed by decantation, twice with hot water, once with boiling dilute nitric acid, twice more with hot water.

Extracting Gold From Gravel Deposits (V.)

By AL. H. MARTIN

The gold dredge forms the fruition of years of experiments with more or less satisfactory devices for winning of auriferous values from gravel beds and bars of streams. The most efficient contrivance ever fashioned for extraction of gold from comparatively deep gravel deposits, its employment has spread to all fields wherever the art of the gold miner is known. It is commonly supposed that the dredge is a product of recent years, but its possibilities were recognized and applied over fifty years ago, even though pioneer efforts were most noted for their failures. The sturdy band of Argonauts that flocked into California in 1849 realized the possibility of constructing a machine that would excavate the rich gravel from unfriendly beds and bars of rebellious streams, and soon after Marshall's epoch-making discovery, a machine designed to dredge the inviting deposits was shipped around Cape Horn to San Francisco. The device was placed in commission on the Sacramento river before the close of 1849, and great hopes were entertained by its owners of a speedy winning of gold treasure from the bed of the turbulent stream. But ere long the boat was at the bottom of the masterful river—a monumental failure in every respect. Succeeding years recorded attempt after attempt to place a successful dredge in action in California and other American states, and always the result was the same—failure, thorough and humiliating

But while attempts at dredging were thus uniformly unsuccessful in America, operators in other fields were meeting with more encouragement. In the early sixties the single bucket, or spoon, dredge was evolved by New Zealand operators. The contrivance in its initial stages was a most crude affair, consisting simply of a heavy bag laced or riveted to an iron frame securely fastened to the end of a long pole. The device was lowered to the bottom of a river or creek and dragged along. The bag was counterbalanced sufficiently that when filled, or nearly so, it could be drawn up and its contents discharged into sluice boxes. Later on a pontoon was used in connection with the so-called bucket, and the material dumped into an auxiliary boat, equipped with washing apparatus. These dredges were at first operated by hand, and later with the aid of current wheels. The first bucket-elevator dredge, as the machine is regarded today, was constructed at Otage in 1867, and results obtained from this and subsequent installations led to the development of the modern gold-dredging industry in New Zealand, and exercised a highly salutary effect on the evolution of the industry in California and other fields. The invention of the steam operated dipper dredge by Ward in 1870 solved the power problem and paved the way for the building of larger and more powerful machines, which were able to handle ground at a cost previously considered as virtually impossible to attain. The idea of the dredge probably followed experiments with the steam shovel, which was employed for excavating purposes years before gold dredging developed, and the modern dredge, representing the most efficient gold recoverer yet devised, most probably was evolved from the ancient spoon dredge of New Zealand and the small steam shovels formerly in vogue.



A CALIFORNIA DREDGING SCENE

FIRST SUCCESSFUL DREDGES.

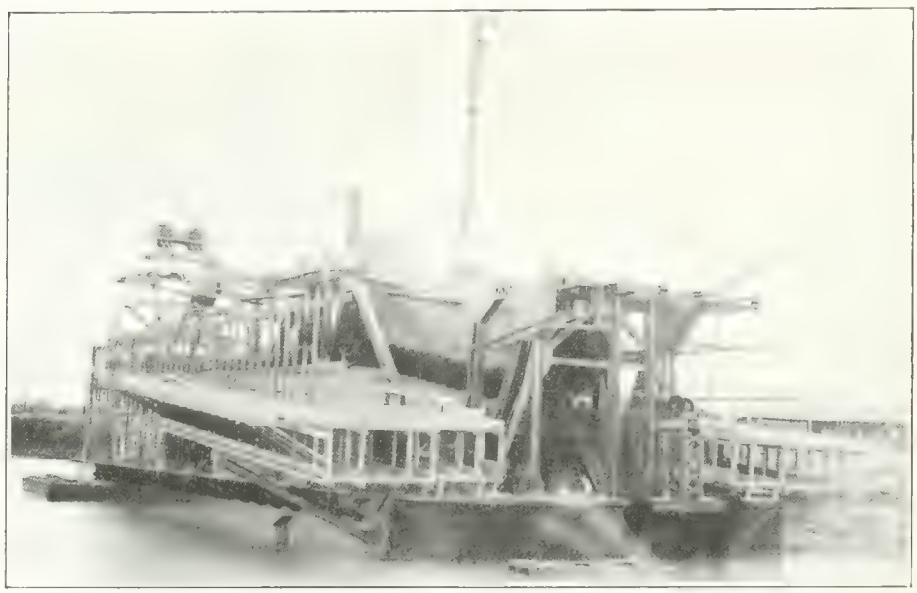
The first successful gold dredges to be operated in America went into commission at Bannock, Montana, in 1894. These boats were of the double-lift, bucket-elevator type, equipped with machinery designed and constructed by the Bucyrus company. The boats operated on Grasshopper creek, and almost from the first proved successful. In 1897 the first single-lift bucket-elevator boat to be constructed in California was placed in action on the Yuba river. It is possible that this installation would have been a success had it been located on some placid stream, but the raging Yuba soon swept the boat on to the rocky shore, and no attempt was made at its rehabilitation. But on March 1, 1898, W. P. Hammon and Thomas Couch placed their famous Couch No. 1 dredge in commission at Oroville, and the era of modern gold dredging was born. This boat was of the single-lift, open-link, bucket-elevator type, and was the result of the experience gained by operators in the New Zealand and Montana fields. From the successful operation of this boat the development of modern dredging has been consistent and rapid.

The first California dredges were generally equipped with 3 and 3½ cubic foot buckets, with a digging efficiency to a depth of 35 feet. Steam was the motive power, but this means of operation soon yielded to the more satisfactory and less expensive electricity. Only the richer sections of ground were handled, but as capacity of buckets became larger, ground formerly deemed valueless was brought within the productive zone. In the brief space of fourteen years the dredge has developed from a small boat handling 1,600 to 3,000 cubic yards per day, at costs of five and six cents per cubic yard, to the mammoth 15-cubic foot designs that turn over 12,000 to 15,000 cubic yards daily, at an approximate cost of two and three cents. And the more modern dredges are excavating to depths of 65 feet and handling a character of material that was formerly considered too difficult for the gold-boat to handle.

REQUISITES NECESSARY TO SUCCESS.

The salient requisites of a dredging deposit are sufficient gold content, enough territory to justify the building

of such a costly contrivance as the dredge has grown to be, and practicability of economic operations. Presence of numerous huge boulders, extensive deposits of clay, uneven bedrock and rough surface contour at times nullify what would otherwise be an attractive dredging proposition. Numerous failures have attended dredge installations because of imperfect or unintelligent examination of the ground, as the tendency too often has been the building of an expensive plant before sufficient prospecting of the deposit was performed. The gradual improvement in machinery and increasing efficiency of the dredges have made the work of the engineer less difficult than in former years, as ground can now be successfully dredged that was formerly beyond the compass of the buckets, but the need for caution still prevails,, as numerous late



Powerful No. 10 Dredge in Course of Construction

failures indicate. The deposit must necessarily be of sufficient extent to contain enough ground to warrant the building of a dredge and return of principal to the investors, with the 10% always regarded as the minimum rate of interest in the industry. Under ordinary conditions, two 7-cubic-foot boats will turn over 500 acres to a depth of 33 feet in about nine years, with allowances made for lost time. Costs in such instances range from around four to about seven cents per cubic yard. A 15-cubic foot boat would do the same work in somewhat shorter time at a cost of two to three cents. The larger the boat, the lower the working cost per cubic yard, all other conditions being equal, but the building of a costly 13½ or 15-cubic foot dredge is not justified because it operates more cheaply per cubic yard, unless the acreage is sufficiently extensive. In the smaller fields, 5, 7 and 9 cubic foot dredges meet with greatest approval, but in really extensive districts the 15-cubic foot designs are the boats par excellence. As an acre contains 4.840 square yards, the engineer can readily figure the cubic yard content of a deposit, and allowing for ground lost in turning over an uneven bedrock, arrive at the best installation for the proposition under consideration.

The value of any device is proven by its ability to yield results under adverse circumstances. And the value of the dredge is largely measured by the facility with which it handles the most difficult ground. California and Alaska operators have been confronted with many difficult problems in this respect, and the overcoming of such obstacles has been of inestimable value in the development of the dredge from its early type to its present high stage of efficiency. California operators have been particularly progressive in dredge building, largely because they were the first called upon to master problems presented by the growth of the industry. The frozen ground of Alaska,, and the dense tropical growths of the tropics have introduced perplexing questions to operators in these fields, but the ability of the dredge to cope with difficulties fully as enigmatic had already been demonstrated in the Folsom and Yuba districts of California.

A DIFFICULT DEPOSIT.

Probably the most difficult deposit to be dredged in California is the Rebel Hill placers, situated in the Folsom district, in the lower portion of the Sacramento valley. This ranges in depth from 50 to 75 feet, with the first six to eight feet partly cemented. Below this extends a body of compact material to a depth ranging from 25 to 30 feet. The gravel between the compact strata and bedrock is loose and easily worked, but the refractory upper material led early operators to consider the mining of the deposit to a depth of even 30 feet economically impossible. It was apparent that only dredges of the most powerful type could be successfully operated, and even then the problem of handling the cemented surface material threatened to defeat the efforts of the most formidable machinery that could be brought against it. But the difficulty was met by the original methods employed by General Manager R. G. Hanford of the Folsom Development Company. A dredge equipped with 73 9-cubic foot buckets was constructed, with every care exercised to make the hull unusually massive to withstand the tremendous strain imposed by the heavy machinery excavating the compact material. Instead of blasting down the cemented graved monitors were used to disintegrate the material with hydraulic streams. Two monitors with three-inch nozzles were placed at the bow, and supplied with water from a high duty centrifugal pump, driven by two 50-horse-power electric motors. At times the water-level of the flotation pond was twenty feet below ground surface, with the first six or eight feet of gravel cemented, but by providing ample washing facilities, the dredge was enabled to take care of the material without difficulty. The two monitors readily undermined and washed down the heavy ground, and the buckets excavated the more loose gravel with comparative ease. The electrical equipment of this dredge (Folsom No. 5) has a rated capacity of 540 horse-power, but in actual operations only about 484 horse-power is required. The pronounced success attending the experiments with this dredge blazed the way for mining of deposits that had previously been deemed utterly beyond the scope of the bucket-elevator dredges, and indicated what might be achieved by devising original methods for handling of individual problems. Folsom No. 5 went into action in December, 1905, a little over seven years after the pioneer Couch No. 1 was launched at Oroville.

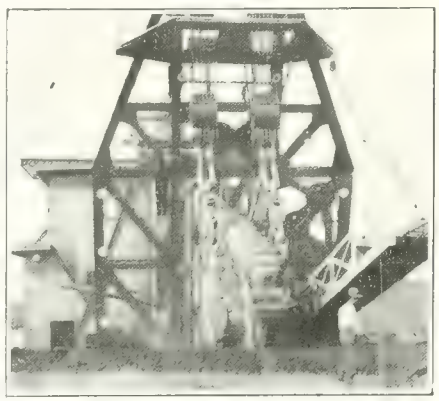
Already in 1904 had W. P. Hammon and R. D. Evans demonstrated the feasibility of dredging successfully to great depths, when Yuba No. 1 and No. 2 boats were constructed to excavate to a depth of 60 feet below water level in the Yuba River field. These boats were the first of their type to dig to such extreme depth, and the modern California dredge, the worlds' standard in gold dredger construction, have been evolved on the lines developed and laid down by the builders

of the early Folsom and Yuba machines. The steel hull, now rapidly displacing those of wood in the case o fthe larger dredges, followed a desire to minimize the ever-present danger of fire, and tne necessity of providing a housing material to resist the voracious attacks of the destructive wood eating insects of the tropics. The tendency has naturaliy been towardt he construction of boats of steadily increasing capacity, when conditions so permitted, because of the lowered working cost which permits mining of ground too low grade to be economically worked by the smaller boats.

The acme of California dredge construction and practice is exemplified in the monster Natomas No. 10 dredge of the Natomas Consolidated of California, which was placed in action in the fall of 1912. The hull is composed directly of steel and displaces about 450 tons, being nearly 300,000 pounds lighter than wooden hulls of identical type. It has a length of 150 feet, with a breadth of slightly over 58 feet, exclusive of the overhanging five-foot decks on each side of the craft. The 90 buckets are arranged in a close-connected line, and easily excavates 12,000 cubic yards per day under rather difficult conditions. This dredge is mining gravel to a depth of 55 feet in the refractory deposit of Rebel Hill. Nine motors developing 1,072 horsepower, are required to actuate the pounderous machinery. High-carbon and manganese steel was used in building the equipment whenever this high-grade material could be advantageously employed. The steel hull is expected to out-wear nearly two like constructions of wood, while the initial cost was about the same as if wood was employed. Growing scarcity of desirable timbers have seriously handicapped builders of the larger California dredges in past years, and replacement of wooden by steel hulls meets sev ral enigmas generated by the growth oi the industry

ALASKAN DREDGE MINING.

Alaska dredge operators have been compelled to solve special questions, generated by the naturally adverse conditions under which work was necessarily conducted. The heavy transportation costs in the far North, add necessity of shipping costly coal and oil for fuel to distant points militates against dredging of all but rich ground in many localities, while thawing of frozen ground and maintenance of sufficient heat on the boats to keep water flowing and machinery from becoming clogged with ice forms items of expense not experienced in more favored climes. For years it was thought that the frozen condition of much of the ground in Alaska, Yukon Territory and other arctic fields would prevent the development of a profitable dredging industry. Most of the early attempts were ignominious failures, and it was not until boats specifically constructed to meet the trying requirements were installed that the reluctant placers yielded golden reward. At the present time gold-dredging is one of the most important industries in the North, the gold boats of Seward Peninsula alone yielding in excess of $1,700,000 per annum. Besides the other obstacles with which they have to contend, Northern operators are hampered by the short season. It is generally deemed poor policy to attempt dredging until the spring frost has been thawed out by the rays of the sun, and most companies make no attempt at commencement of work before June 15. Early in the fall work is suspended in time to permit the men to embark on the last boat bound for the south Attempts have been made to operate for



Close View of Business End of Natomas No. 10 Dredge in Action.

longer periods, but the great difficulties attending working of frozen ground has generally decided against the practice.

When it is imperative that the ground be thawed by artifical means, a boiler and steam points are impressed into service. The boiler generally ranges from 25 to 50 horsepower, with 15 to 20 points employed. The points are simply iron pipes, pointed at the bottom to facilitate driving into the hard soil. soil. The points are driven down a few feet and steam introduced from the boiler. The heat thus formed slowly thaws the round and permits the dredge buckets to dig the material. The thawing is done with little difficulty to a depth of eight feet, but as additional depth is required, the work becomes constantly more arduous and costly. It has been asserted that ground has been thawed and dredged to a depth of 50 feet in Alaska, but that this has been done on a permanently successful scale is denied by Northern operators Thawing ground to depths of six and eight feet, with fuel costs fairly moderate, means an expenditure of approximately 20 cents per cubic yard. Several companies in the Yukon thaw and dredge gravel to a depth ranging from 15 to 25 feet, the cost depending on the extent f frozen material, and degree of hardness. It is evident that the adverse conditions under which Northern operators work militates against handling of any but high grade gravel, as the operating costs are vastly in excess of the rates prevailing in California and other southern districts.

Dredges in the North range from boats of the smallest type to the 16-cubic foot monsters of the Canadian Klondyke Mining Co. Many of the machines are provided with steam heating appliances, which are placed in close proximity to all parts requiring protection from the intense cold. Not infrequently operations are carried on with the temperature more than 20 degrees below zero, but with hot water and steam, operations are conducted with about the same ease as prevails in warm weather. High cost of fuel has ever been a factor reacting against low operating charges, and operators have constantly endeavored to cut down this expensive factor. During the past year several companies discarded coal in favor of the more economical crude oil, while other operators have evinced a tendency toward the gas engine when installations were situated at a considerable distance from supports. Under favorable conditions, Yukon and Alaska dredges handle gravel at a total cost of 12 and 13 cents per cubic yard—the record comparing favorably with operations in other fields, where the high power and fuel costs are taken into consideration. California type dredges are largely used in the North, with most of the boats constructed by leading American builders. Aside from solving the complex enigmas attendant upon dredging under such unfriendly conditions, the operators of Alaska and the Yukon have demonstrated that the modern bucket-elevator dredge is capable of wide application, and can be profitably employed under circumstances and handicaps that a few years ago were considered prohibitive for economical work.

TROPICAL REGION DREDGING.

Sharply contrasting with conditions in the frigid wastes of the Arctic are the problems that confront the dredge operator in tropical regions. Here dense undergrowth forms a formidable barrier to the advance of the gold boats, and demon-like insects make existence a missery for all concerned. The fiendish pests not only attack men, but direct their assaults upon the wooden hulls of the dredge, and in a few months ruin the staunchest craft ever launched.

Sudden floods must also be guarded against, with many other factors forcing constant consideration. The first move is the clearing away of the dense tropical growth on the deposit, and to resist the attacks of the wood-eating insects steel hulls are employed. It has been thought that roots of tropical growths in the deposits would seriously interfere with dredging, but with boats of latest design little difficulty has been experienced from this source. Of course, the presence of numerous roots, tree trunks and boulders naturally inpedes work to some extent, but it has been demonstrated in Columbia, British Guiana, Philippine Islands and other tropical fields that such impediments are not prohibitive bars to successful mining The constant danger of floods have led operators to locate their dredges a short distance inland, and in this way minimize the damage following sudden high water. Operations in the past have been handicapped by employment of small and inefficient dredges, but a more progressive spirit is being displayed, and many of the newer installations embody the latest advantages developed by years of practice in other fields.

Before the installation of a dredge is decided on in any field, the character of the deposit should be conclusively known. This can only be accomplished by systematic examination of the ground. While drills are largely employed in this work, the most satisfactory method is incontestibly the prospect-shaft, whereby the average value of ground and structure of deposit is known beyond all question. A high gold content does not always mean the ground is a desirable dredging proposition, as many other factors may militate against successful operations. It has too often been the practice to build the dredge first and prospect afterwards, and because of this many promising installations have been complete failures. Comprehensive prospecting is expensive, but the building of a useless dredge is even more so. When Hammon and Evans became interest in the possibilities of the Yuba River field, California, they proceeded to thoroughly test the extensive acreage before venturing upon the building of a single boat, despite the highly promising indications The period of prospecting consumed about two years, during which time over 300 drill holes and prospect shafts were sent down. It meant the expenditure of nearly $100,000, but the engineers were enabled to plan the type of boat that would be the most successful in this particular case. As the cost of a modern California-type dredge ranges from $50,000 for the small desings to $225,000 and $300,000 for the largest boats, it is evident that comprehensive and intelligent preliminary prospecting is essential, even though it may be attended with considerable expense. For the information thus gathered may mean the saving of thousands of dollars for the investors in the enterprise.

MINE VALUATION BY THE PUBLIC

By HEATH STEELE.*

Judging from market quotations on mining stocks, the public either does not care about the real investment value of a mining security or else is wholly lacking in knowledge of the fundamentals of mine valuation. No one should expect the average buyer of mining stocks to be an expert at appraisal, but there is such a great difference displayed in the ability to appraise mining and industrial stocks that one cannot help wondering if the gambling element does not trade more in these stocks than in the other forms of securities. Some time ago I had occasion to look up the interest returns on mining and railroad stocks based on the average market quotations, and was surprised to find the public was buying both stocks on about the same basis. To anyone who understands mining, this is ridiculous, as a railroad is at least supposed to maintain it assets, if not actually increae them, while a mine is naturally worth more at the beginning of dividends and depreciates thereafter rapidly in value So much has been published in the technical and financial press of late on the valuation of mines that it is reasonable to suppose the public is more enlightened on the subject. I am inclined to think this is true, as the recent high prices do not show the overvaluations of 1906 and 1907, but there is still a lot of educational work to be done along this line.

The table given herewith shows the high and low records of 40 copper stocks for a 12-year period, 1901 to 1912. Of these mines, 20 have paid dividends and 20 are non-dividend payers.

	12-Year Period, 1901-1912.				1912.	
Non-dividend-paying stocks	Low record	Date	High record	Date	Low record	High record
Adventure	$ 0 6.25	1904	$ 33.00	1901	$ 5.00	$ 11.25
Allouez	1 75	1901	121.00	1907	35.00	50.25
Arizona Com	0 10	1911	52.00	1906	2.00	6.87
Centennial	8 00	1911	47.00	1907	15.50	27.50
East Butte	3 50	1908	18 25	1907	12.25	16.78
Franklin	5 50	1911	29.25	1907	6.75	16.50
Giroux Con	2 37	1907	10 50	1907	3.12	6.37
Hancock	3 25	1908	38 00	1909	22.00	37.00
Helvetia	0.70	1912	7.50	1909	0.70	1.12
Isle Royale	5.25	1903	56 50	1901	20.75	37.25
Keweenaw	0 50	1911	23 25	1905	0.99	2.62
Lake	1 00	1907	94.50	1910	22.75	49.00
La Salle	3 00	1911	35.00	1907	4.50	8.00
Mass Con	2 25	1908	37.62	1901	5.00	9.00
New Arcadian	0 25	1904	24.75	1901	2.00	6.25
Superior	7 00	1907	68.25	1910	24.00	48.87
Trinity	2 87	1911	42.25	1907	4.00	9.50
Victoria	1 00	1911	12.00	1901	1.75	5.87
Winona	1 00	1902	15 25	1905	3.12	7.75
Wyandotte	0 10	1907	3 75	1910	1.00	3.25
Dividend-paying stocks.						
Anaconda	$ 15 37	1904	$ 74.00	1906	$ 34.50	$ 48.00
Ahmeek	15 00	1907	370 00	1912	240.00	370.00
Calumet and Arizona	15 00	1911	198.00	1907	57.50	83.50
Calumet and Hecla	360.00	1911	1000 00	1907	405.00	615.00
Copper Range	34 00	1901	105 00	1907	48.50	66.50
Tamarack	20 00	1911	363.00	1901	26.00	51.00
*Granby Con.	20.00	1910	151.00	1907	33.00	77 75
Greene-Cananea	5 25	1907	26 00	1906	7.37	11.12
Mohawk	22.00	1901	96 50	1907	50.25	73.00
Nevada Con	6 25	1907	30 00	1909	18 25	24.62
North Butte	18 50	1910	120.00	1907	22.75	39.50
Old Dominion	5 00	1903	64.00	1912	44 00	64.00
Osceola	43.50	1903	181 00	1907	100 00	130.50
Parrot S & C	7 87	1911	58.50	1901	12.75	14.50
Quincy	55 00	1911	187.00	1907	72.50	95.00
Shannon	3 50	1904	24.37	1907	9.00	17.87
Tennessee	9 12	1901	55.50	1907	35.12	46.75
Utah Con	9 50	1912	79.00	1907	9.50	20.50
Utah Copper	13 00	1907	67.37	1912	52.50	67.37
Wolverine	42 00	1902	200.00	1907	65.00	117.00

*New stock.

*Mining Engineer, New York, in Mining & Scientific Press, March 8, 1913.

A RECORD OF PRICES.

It will be noticed that practically all the high records were made about 1907, when the price of copper was high. The non-dividend payers serve to show how the hopes and expectations of the public rise and fall, and the enormous prices paid for prospects. For example, basing the calculation on the present outstanding stock, this group of mines were given a market valuation by the high quotations, of $125,392,000, but when optimism gave way to pessimism, as recorded by the lowest quotations, the public's opinion of these mines depreciated $114,439,000 and the appraisal was only $10,953,000 for the group. Some may say this occurred over a long period in which many things happened; that some of these properties looked promising enough at one time or another to warrant a high valuation. But can there be any sound reason for the public's hopes fluctuating 90% in 1912? The record shows the low 1912 valuation of these non-dividend payers to have been $29,423,000 and the high selling prices to have added $26,430,000 to this amount, giving a total valuation of $55,853,000 to the same mines. It is not the valuation of $125,000,000 that staggers one so much as what the public expected of these properties when it placed that valuation upon them. For if a 15-cent average price for copper, and an 11.5c. cost be allowed, which is a very fair cost for these properties, and only a 6% average annual dividend be asked, it would mean that each should produce about 10,700,000 lb. copper per year for 41 years, or a total of almost 9,000,000,000 lb., figuring interest at 5% on the investment This would mean practically another Lake Superior district. If these mines be appraised at the average between the high and low quotations of 1912, the valuation would mean the successful development of about five mines out of this group. If the low cost of 9.5c. per pound on 15c. copper be allowed, it would mean a total production of about 400,000,000 lb. each in 41 years, figuring on a 6% annual dividend. The production of the Quincy mine, which has paid dividends for over 41 years, has been about 500,000,000 pounds.

DIVIDEND PAYING MINES.

Studies of the dividend payers yield figures that give good evidence of the public's erratic appraisals. The high quotations yield a vaulation of about $1,063,000,000 placed on these mines, or 366% over the low quotations, which give a valuation of $228,306,000. In 1912 the public appraised these same mines from $465,747,000 to $659,359,000, a difference of 41.4% over the low valuations These mines have paid approximately $217,000,000 in dividends during this period, or an average of about $18,100,000 per year. If the valuation of $1,063,000,000 placed upon this group be taken, the result figures to 1.71% income The average annual dividend for the last six years has been $23,367,000, or 2.2% income; on the basis of 1912 dividends, $34,322,000, the return would be 3.2% This is all that is necessary to say for this valuation.

Based on the lowest valuation, $228,000,000, the average rate of income for the 12-year period has been 7.95%, and for the past 6 years 10.1% On the basis of 7.95% income, with interest at 5%, would mean an expected life of about 21 years for these mines, and on a 10% income a 15-year life. The high valuation of 1912 with an annual dividend of $18,100,000 would give an income of 2.75%; on the 6-year average of $23,367,000 the income would be 3.5%, and at the 1912 dividend-rate, 5.2%. This means that these mines would practically have to last forever and pay at the rate of 1912 dividends, which is about 17% higher than previous years, if bought at the high valuation on a 5% interest basis. On the low 1912 valuation, $465,747,000, the rate of interest return on the 12-year average dividend is about 3.9%, on the 6-year average dividend 5.05%, and at the 1912 rate about 7.46 per cent.

MINES ARE OVERVALUED

As the majority of these stocks must have been traded at prices between the high and low average of the two 1912 valuations, $562,000,000 may be taken as indicating the real valuation placed upon these mines by the public. On this the interest return would be 4.15 and 6.12% respectively for the 6-year average and the 1912 dividends. If dividends will equal the 1912 rate for about 40 years, this valuation will be justified. It is evident from these facts that mines as a whole are consistently over-valued by the market quotations. However, one can very often point to undervaluations in the case of single mines, particularly those operating along sound business lines—not agitating with printer's ink and concentrating (the public's attention) with printing presses.

USE OF EXPLOSIVES IN THE TROPICS

By CHARLES S. HURTER.*

While it is the intention of the writer in this article to cover the use of explosives in tropical countries, it is also necessary to discuss in considerable detail points that are of great importance in regard to the proper use of explosives on all kinds of work, in any latitude. The beneficial results of strong detonators and good tamping are of the utmost importance. Also the careful attention that must be given to the storage of explosives in tropical countries cannot be overlooked.

Guttmann divides explosives into two classes, namely, low explosives and high explosives. Low explosives are those which can be made to develop their full force by direct means, such as simple ignition. The principal explosive in this class is blasting powder. Practically all the sporting and ordnance powders belong to the low explosive class. High explosives are that class of explosives that require an intermediate agent, such as a fulminate detonator, to cause them to develop their full explosive force.

There is one exception to this method of classifying explosives. Fulminate of mercury, and mixtures with this as a base, such as are commonly used in blasting caps and electric fuses or detonators, together with nitrogen iodide, silver oxallate, nitrogen sulphide and other explosive freaks, have the action of high explosives, but develop their full force upon simple ignition. A large number of authorities place them in a third class called fulminating explosives.

The action of blasting powder on exploding is that of a very rapid process of oxidation. As a contrast to this, the action of high explosives consists principally of a simple dissociation of compounds, followed by an oxidizing action, such as the reaction between the oxygen excess present when nitroglycerine is detonated and the compounds placed in the absorbent or "dope" of dynamite to take up this excess and secure the so-called "balance of formula."

Another classification shows low explosives to be mechanical mixtures, such as blasting powder; while high explosives can be regarded as chemical compounds.

In the low explosive class, the action takes place by means of the reaction of the particles composing the different

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substances in the mixture upon each other, the explosion being propagated from one group of such particles to the next and so on throughout the entire mass. An explosion so produced is necessarily relatively slow. A shock, unless of such extreme violence as to produce friction, will not explode blasting powder.

The case is different with high explosives. Here the elements that make up the explosive compounds are combined into definite molecules of uniform composition, held together by a relatively feeble chemical attraction. A shock will overcome the bonds which hold these elements together upon which they are free at once to react upon each other, producing gases at a high temperature, the result being an explosive effect. An explosive wave is thus generated, which is continued throughout the entire mass. Thus perfect combustion is accomplished in an infinitely small space of time and an effect of particular violence is obtained, which has been called "detonation."

MANUFACTURE OF DYNAMITE.

The high explosives or dynamites used for blasting in the United States are divided into three classes, commonly known as nitroglycerin dynamite, extra or ammonia dynamite and gelatin dynamite.

The first dynamite that appeared on the market was composed of 75 per cent nitroglycerin and 25 per cent of an infusorial earth called kieselguhr. The kieselguhr being an inactive substance consumes some of the strength of the nitroglycerin and detracts from its sensitiveness. The result is that the 75 per cent kieselguhr dynamite is only about as strong as the American 40 per cent, and kieselguhr dynamite containing less than 40 per cent of nitroglycerin cannot be exploded by ordinary means.

Another of the earliest absorbents used for nitroglycerin was sawdust. It was from this that the American dynamites of the present day were evolved. Theoretically, when nitroglycerin is detonated, five per cent of the gases given off is free oxygen. The dope of the dynamite is made up largely of wood pulp and either sodium or potassium nitrate in proportions to make a complete balance of the chemical reactions which take place on detonation. Dynamite made in this manner may contain as low as 12½ per cent or as high as 75 per cent of nitroglycerin and constitutes what is known at the present time as the nitroglycerin dynamites.

The series of nitroglycerin dynamites constitute also the standard series against which all other explosives are compared, and contain or should contain the actual proportion of nitroglycerin that is given as their "percentage strength."

One of the characteristics of the nitroglycerin dynamites is their very quick and shattering action. This quickness increases with their strength. The water resisting qualities of the nitroglycerin dynamites are better in the higher than in the lower grades. The fumes from the nitroglycerin dynamites are the poorest of the three classes of dynamite, the lower grades giving off less deleterious gases than the higher. The nitroglycerin dynamites are all very easily ignited by flame or sparks such as might issue from the sides of defective or the cheaper grades of fuse. Therefore, considerable care must be used in the making and placing of primers when using nitroglycerin dynamite for blasting.

By replacing part of the nitroglycerin with nitrate of ammonia a series of explosives having strengths similar to those of the nitroglycerin dynamites are obtained, called extra dynamites. This class of explosives has distinguishing characteritics that make them very valuable for certain kinds of work.

As the extra dynamites contain less nitroglycerin than the corresponding grades of Nitroglycerin dynamite, they have a somewhat slower action. The fumes are very much superior to those of the nitroglycerin dynamites. They are the most difficult of any of the ordinary high explosives to ignite. It is practically an impossibility to ignite extra dynamite from the side spit of any kind of fuse or even if the end of a length of fuse is inserted in the cartridge without a blasting cap.

The water resisting qualities of extra dynamites are not so good as those of the nitroglycerin dynamites, but this difference can be almost entirely overcome by dipping the cartridges in melted paraffine after filling. The sensitiveness of extra dynamites is less than that of the nitroglycerin dynamite, and therefore nothing less than a No. 6 detonator should be used to explode them.

In the course of the experiments made by the late Alfred Nobel with explosive compounds, he found that he could dissolve some of the lower grades of guncotton in nitroglycerin, forming a waterproof explosive jelly that was slightly stronger than the pure nitroglycerin itself. This jelly is the base of the present blasting gelatin, gelatin dynamite and gelignite. The gelatin dynamites have a relatively slow, heaving effect when exploded by No. 6 detonators, but when detonated by a primer of strong nitroglycerin dynamite or of blasting gelatin, they have more of a quick, smashing action than the corresponding grades of nitroglycerin dynamite. Still, when fired by means of a No. 6 detonator, the more effective load, due to the density and plasticity of the gelatin dynamites, more than counterbalances the deficiency in quickness when compared with the corresponding strength of nitroglycerin dynamite.

These gelatins are the densest of the high explosives, which fact makes them very valuable for tight blasting where a concentrated charge is desired at the bottom of the bore holes. The fumes are superior to those from both the nitroglycerin and extra dynamites. Being very nearly waterproof in the lower and perfectly waterproof in the higher grades, the gelatins are best adapted for use in extremely wet work and submarine blasting.

DYNAMITE IN TROPICAL CLIMES.

In only the very dry sections of the tropics can all of the explosives of the temperate zones be used with success. While the extra dynamites are the greatest favorites in the United States, there are very few places in the tropics where they will not be spoiled by the climate in a relatively short time.

The E. I. du Pont de Nemours Powder Company has made a special study of explosives for use in tropical countries, and as a result the du Pont gelignite has become one of the standard dynamites for export trade. This belongs to the gelatin class, but has a few changes in its ingredients to improve its keeping qualities under severe conditions of transportation and storage.

Along the northern edge of the tropics, as in Mexico and Cuba, with a few exceptions the same explosives and style of cases can be used as in the United States, because the closeness of the market to the source of supply makes long storage unnecessary.

The excessive heat and humidity of the tropical rainy seasons places a very serious problem before the manufacturers of explosives. A very large number of explosives that will not remain in good condition if exposed for any length of time to a tropical climate have become great favorites in the Temperate Zones. Also the making a climate proof explosive often narrows the range and cuts down some of the more desirable features of explosives that can be used under better conditions. Where the transportation conditions are not too severe and where the injury to cases in shipment is a minimum, special air tight packages can be used that, when handled carefully, will keep any standard explosive in good condition for an indefinite time.

The gelignites are dense, fumeless and nearly waterproof. Their strengths are rated according to their actual nitroglyc-

erin contents, viz.: 34 per cent, 42 per cent, 51 per cent and 62 per cent, which correspond to the 40 per cent, 50 per sent, 60 per cent and 75 per cent strength gelatin dynamites of the United States. They are very plastic, giving a very effective load for tight blasting and they stick well in uppers.

For latitudes nearer the equator the greatest care must be taken to protect the explosives from the effects of the climate during shipment and storage. The cartridges are all dipped in paraffine after filling in order to make them airtight. The cartridges are then packed in cartons, each carton containing five pounds net weight of explosives. Ten cartons are packed in each case, which is made of heavier wood than those used for domestic shipments. For extra protection the cartons have an airtight bag to hold the cartridges, or the cases have a double lining of special waterproof paper.

In these countries extra dynamites cannot be used unless shipped quickly and not allowed to remain any length of time in storage.

It is in these places that the gelignites have given the best results. Their composition is such as to enable them to remain in good condition in the heat and humidity of the tropics longer than any other explosives.

Blasting powder is very effective for large blasts in open work. It has a slow, heaving action that is well suited for shaking up large quantities of material. Blasting powder is made in two series, one using nitrate of potash or India nitre and the other nitrate of soda or Chili nitre, as oxidizing agents. The potash powders withstand the effect of moisture a little better than the soda powders, being a little slower than the potash, have a better spreading and heaving effect.

The keeping qualities of both powders depend mostly on the tightness of their container. The standard steel keg holding twenty-five pounds net weight of powder, is rough and careless. Most manufacturers have special airtight packages for blast powder, which they furnish at reasonable charges to cover the extra cost of packing.

The use of blasting powder is naturally confined to dry work, as it is instantly ruined by contact with water. In the United States it is manufactured in hard and soft grains, both of which may be glazed or unglazed. On account of the ease with which the soft grain and unglazed powders absorb moisture, hardly anything is used but the hard grain glazed powders. The principal features of this latter variety are its density and the bright polish of the grains. It runs freely into down holes and packs well in place, forming a very effective load for heavy blasting. The best method of firing large blasts of blasting powder is to use dynamite primers with electric fuses placed in the center of the charge. This kind of a primer insures ignition at the center of the charge, and the large flame on ignition insures a more violent action from the powder than would be the case if exploded by only the spit of ordinary fuse. Also the ground will be broken up in better shape if a line of holes is fired at one time in this manner by electricity.

In practice, detonation is accomplished by means of an intermediate agent that will produce both shock and heat. The relative amounts of shock and heat depend on the composition of the detonator charge.

DETONATORS AND REACTIONS.

Fulminate of mercury is the compound which forms the basis of all detonator charges. According to Berthelot, this is the most powerful detonator. This is to say, the shock from fulminate of mercury is quicker and more violent than that of any other substance used for producing detonation. This is explained by the suddenness of its decomposition, together with the extraordinary magnitude of the pressure which it would develop when detonating in its own volume.

In regard to the phenomenon of detonation, the action which takes place depends more or less on the strength of the initial pressures, on the suddenness of their development and the relative stability of the compounds used to make up the explosive, which, in turn, regulates the ease of the communication of the shock to the rest of the mass. That is to say, the action which takes place de- up the explosive, which, in turn, regulates the energy transformed into heat in a given time on the first layers of the explosive substance reached by shock.

The quantity of energy thus transformed depends, therefore, both on the suddenness of the shock and the amount of work it is capable of performing.

Mixtures of fulminate of mercury with other compounds are made with the object of increasing the amount of heat liberated and thus the pressure of the gases formed. The compound most commonly used for this purpose is chlorate of potash. The decomposition of chlorate of potash into potassium chloride, and oxygen liberates a certain amount of heat, and the conversion of carbon monoxide into carbon dioxide generates a great deal of heat. On the other hand, this oxidation being a secondary reaction, the shock is not quite so sharp, but as detonation can be caused by heat as well as by shock, it is possible to use mixtures where the great gain in heat more than counterbalances any deadening of the shock.

According to this reaction, 245.2 parts by weight of chlorate of potash must be mixed with 852.12 parts of fulminate of mercury to bring about complete combustion. Roughly, this proportion can be expressed as 2 parts of chlorate to 7 parts of fulminate. The mixtures in use vary from 80 per cent fulminate and 20 per cent potassium chlorate to 95 per cent fulminate and 5 per cent of chlorate of potash, the idea being to get a mixture in which the heat developed will give the greatest assistance in producing detonation without deadening the initial shock of the fulminate.

METHODS OF STORING.

One of the greatest causes of trouble in the use of explosives in tropical countries is improper storage. In the heat and humidity of the tropics the construction of proper magazines is of even far more importance than in the temperate zones. It is fairly common to find magazines for the storage of explosives with a damp dirt floor and no provision for ventilation. In some of the almost airtight magazines that the writer has visited in the tropics, the temperature has been all the way from 120 to 130 degrees Fahrenheit. If more attention were paid to the proper storage of explosives, a great deal less trouble would be experienced by the consumers.

The E. I. du Pont de Nemours Powder Company has taken the lead in trying to remedy this trouble, by sending its customers, free of charge, on request, complete plans and specifications of magazines to store any quantities of explosives.

It is of the utmost importance that magazines should be dry and well ventilated. If the ventilation is not good the temperature is liable to be high enough to cause even gelatins and gelignites to leak. The ventilation should be under the floor as well as through the interior of the building. The air current under the building not only aids materially in keeping the temperature down, but keeps the floor dry.

The packages of explosives from the principal manufacturers have their trademarks as well as "THIS SIDE UP" on the tops of all cases of high explosives. by having the cases with the top side up, the tendency for the nitroglycerin to collect at the lower end and possibly leak from the cartridges is entirely obviated, as the cartridges are all lying on their sides. The tendency for leakage of the liquid contents, if the cartridges are stored on end, is more pronounced at high temperatures, so it is of the utmost importance in tropical countries for high

explosives to be stored with the cartridges lying flat.

In the storage of blasting powder, it has been found that there is less possibility for the entrance of moisture if the kegs are placed on end, bung down. For a long time it was customary to stack them on their sides, but careful observations over a long term of years by the E. I. du Pont de Nemours Powder Company has shown conclusively that when the kegs are kept on end, bung down, the powder will remain in good condition for a much longer period of time.

In the building of magazines, the Spanish-American countries seem to prefer thick stone or adobe walls, with another one surrounding it. While this forms an excellent protection against bullets or other outside causes of accidental explosion, these walls are immediately converted into thousands of missiles, which are thrown broadcast over the country if an explosion occurs.

Two courses of soft brick (nine-inch wall) laid in cement mortar, are sufficient to stop a steel-jacketed bullet fired from a modern high-power military rifle. The mortar should be laid as thin and compactly as possible, to exclude even the most minute air spaces. By using soft brick, if an accidental explosion takes place, the walls are instantly converted into dust and there are no missiles. Instead of stone or adobe walls surrounding the magazine, earth embankments form just as good protection and will not become dangerous projectiles in case of accidental explosion.

Magazines can be bullet proofed by putting a wooden lining inside the walls and filling the space between it and the outside wall with coarse, dry sand. When smokeless powder is used in high-power military rifles it takes eleven inches of dry sand to absolutely bullet proof a magazine, but with the 30-30 Winchester or equivalent, which is the strongest rifle in common local use, eight inches of dry sand is sufficient.

USE OF DETONATORS.

Another great cause of poor results in blasting is the use of weak detonators. For years the South and Central American countries have been used as a dumping ground, by European manufacturers, for weak blasting caps and electric fuses. In their own countries the use of anything weaker than a No. 6 detonator is prohibited by law, yet they seem to think that anything is good enough for Spanish-America. The cheaper price of weak detonators appeals to many, but the difference in price between one of them and a No. 6 detonator, which is only a fraction of a cent, may mean the difference between a good and a bad blast. It takes only a very few bad blasts to more than cover the difference in cost between a year's supply of weak detonators and strong ones.

Berthelot, the greatest authority on explosives, states as follows:

"The reaction induced by a given shock in an explosive substance is propagated with a rapidity which depends on the intensity of this shock, because the energy of the first shock transformed into heat determines the intensity of the first explosion and consequentl the intensity of the entire series of consecutive effects. The more violent the initial shock the more sudden will be the induced decomposition, and the greater the pressure generated during the entire course of decomposition."

In short Berthelot claims that the action of any explosive is stronger when fired by means of a high-power detonator than with a weak one. Bichel and Guttmann also make the same recommendation.

During the last few years the manufacturers of explosives have paid great attention to the safety features as regards the handling of their products. The result is that the explosives on the market at the present time are not as sensitive as the dynamite sold a few years ago. This has resutled in a great reduction in the annual number of accidents in the handling and use of explosives, but it also makes the use of strong detonators of more importance than it was four or five years ago.

The use of a strong detonator in a large number of cases also overcomes possible trouble due to improper or careless charging of explosives. Also if the strong detonators have not been stored properly they can resist a greater quantity of moisture without becoming useless than can the weaker ones. Actual analyses of gases after blasting underground have shown the presence of smaller amounts of bad fumes when strong detonators are used. Some of the poisonous gases formed by improperly detonated explosives are odorless, so the sense of smell alone cannot be relied upon to prove or disprove the presence of bad fumes after blasting. In the United States a large number of mining companies, after careful experiments and tests, now use only No. 8 detonators, which are twice as strong as the No. 6. Spanish America has been a dumping ground long enough, and all users of explosives should insist on being furnished with nothing weaker than No. 6 blasting caps or electric fuses. The charge of a No. 6 detonator consists of one gram (15.43 grains) of the standard fulminate mixture.

Almost everywhere there is considerable discussion in regard to the use of tamping. Some claim that tamping is entirely useless; a very large number say that enough to make the hole airtight is sufficient, and a few still believe that by tamping the hole solid to the collar the best results are obtained. The last idea corresponds to the writer's opinion.

When an explosive substance is detonated in its own volume, the maximum of temperature and pressure, and consequently the maximum speed of the chemical reaction involved, is attained; that is, the total heat possible to develop in the reaction is obtained at the instant that the energy of the explosion is exerted on the surrounding medium.

MANUFACTURE OF FUSE.

During the past five years there has been a wonderful improvement in the manufacture of fuse. The use of a cord winding has largely replaced the tape. The fuse made in this manner (countered fuse) has become a great favorite over the tape varieties. It is more flexible, less liable to break or crack when bent sharply, and has the same water-resisting qualities as the corresponding grade of tape fuse. In the eastern and central sections of the United States, the Crescent brand, manufactured by the Ensign-Bickford Company, has largely replaced the doubletape fuse. The countered fuses are much cleaner to handle, and will not stick together in the coils during hot weather like the tape fuses.

In conclusion, the writer recommends for use in tropical countries the gelignites, which are the best water-resisting explosives on the market. They rarely leak nitroglycerin on long storage or when exposed to excessive heat and humidity, as often happens with explosives containing nitroglycerin in a liquid state.

The utmost care should be taken to have the proper storage conditions for explosives in the tropics, as a very large amount of trouble can be traced directly to faulty magazines. Strong detonators should always be used. The advantages of these are shown very emphatically by the work done in hard rock and the better fumes in close places. The larger companies who specialize in the manufacture of explosives for use in the tropics should be consulted in case of trouble, as they are generally in a position to offer sound advice.

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Salt Lake is becoming the "City of Apologists." When our friends visit us from other states and cities we find ourselves apologizing for the smoke, and for the loss of the beautiful city views and mountain panoramas that we used to own ———o———

Copper production of Canada in 1912 was 33,000 long tons.

Mines and Methods

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CONTENTS:

"Spieler" for the "Commercial Club" excursion to Bingham: "Ladies and gentlemen: We have now arrived at the 'greatest copper camp on earth.' On your right is the workings of the Utah Copper Company. You came here, no doubt, expecting to see how the steam shovels operate on the 'ore,' 'near ore' and 'waste' that is mined and hauled to the mills of the company at Garfield and converted largely into tailings. Were it not for this high board fence and the army of 'fighting deputy sheriffs' which guard the gates and all approaches to the property for fear that a representative of Mines and Methods might slip through, we should be glad to have you all see this magnificent, shimmering mountain of copper ore in all its splendor and dazzling brilliancy of color; but, for the reason stated, you will have to content yourselves with whatever peek through the knot-holes of the fence you may be able to obtain unobserved by the deputies. Then we shall get ready for the return trip."

The Pending Crisis In Utah Copper

For several months past the subsidized press of the Utah Copper Company have made frequent comment on the fact that the Nevada Consolidated Company has, in the working of larger quantities of low-grade ore, demonstrated that a good profit can be made on ores containing no more than one per cent copper. In fact it was said that ores containing as low as eight-tenths of one per cent copper had been treated at a profit by that company. These facts were also mentioned by Manager Jackling with the evident intent of impressing the public with the perfection of the methods and processes by which ores are mined and treated at the several properties under his management, and also, to avoid any shock which might result from his late announcement that upon the properties of the Utah Company, it has been found that a large portion of material which had theretofore been regarded as capping, and which contained one per cent copper and less had, during the period covered by the last quarterly report, been sent to the mills and treated with satisfactory results. In fact, the report showed that the entire tonnage of ore sent to the mill for the period covered, contained barely one per cent copper.

We have already shown how the tonnage of the Utah Copper has been increased from time to time by including in the estimates neglected quantities of comparatively barren rock, and how, to afford justification for the continued use of steam shovels, the stripping on Boston-Utah ground, which had become of a thickness of some two hundred feet, and therefore impossible of economical stripping, had been in the later estimates of ore reserves, sliced off from the bottom and added to the vast sum of three hundred million tons of ore theretofore reported But, with all their juggling with facts and conditions, the Utah management, through its press, has deftly contrived to make it appear that the large bodies of high-grade ores, of which so much was said in earlier reports, still remain untouched and to be drawn upon at convenience when these low-grade rocks shall have been disposed of, thereby affording easy access to the high-grade reserves which are to be drawn upon for dividends when market conditions shall justify pegging the price of Utah shares at a higher level.

But the cold facts are that, as frequently shown by this journal, the higher grade ores have from the first been drawn upon by underground burrowing until every available vestige of such ores has disappeared; the result being—as must have been noted by all readers of Utah reports— a persistent dimunition in the copper content of the rock treated, until the best of that remaining, of which there is doubtless a very large volume, contains barely one per cent, or twenty pounds of copper per ton, and that overlain by some 200 feet of absolutely worthless rock which must be removed if the steam shovel folly is to be continued. Of course, as we have also previously shown with respect to the high grade ores, no possible profit can possibly be derived from the mining and treatment of ores of this grade by the Utah company, if its former methods are to be continued. Whenever the real facts shall have been exposed it will be shown that for the past six months there has been an actual loss of at least two and a half cents upon every pound of copper produced by the Utah company.

It was given out by the manager and the press that from a short time prior to the first of March operations had reached the normal production of 20,000 tons per day, or 620,000 tons for the month of March; in fact, it has been said that as much as 25,000 tons per day was handled for a portion of the month, it being understood at all times that a sufficient excess over the tonnage reported—to cover the moisture, depreciation and metallic contents—is always included, if not understood.

Reports just received from the eastern offices show that the production of copper in concentrates for the month of March was a little over eight million pounds which, divided by the tonnage treated, gives a gross yield of about thirteen pounds per ton of ore as compared to a yield of about twenty-one pounds as shown by the annual report for the year 1911—a deficit in the production for the

month of March, this year, of about eight pounds of copper per ton of ore—and in value, about $1.20 per ton. The reputed net yield from all sources for the Utah plant for the year 1911 shows an apparent profit of about 90 cents per ton of ore treated, all of which, with an addition of thirty cents a ton, would have been wiped out had the yield of copper been thirteen pounds per ton for the month of March instead of twenty-one pounds as reported for the year 1911, or a direct loss in addition to all the ore treated of thirty cents per ton, being $186,000 for the month.

When we come to consider that notwithstanding the purported large earnings and payment of dividends during previous years, when operating upon a higher grade ore, the company is now struggling with a floating debt of some $8,000,000, what must be the condition of the company's exchequer if present methods and conditions be continued a few years longer, we leave to the conjecture of shareholders.

We are quite willing to concede that the result of operations on low grade ores by the Nevada Consolidated, as reported, are perfectly feasible and credible, but conditions and the direct management at the Nevada Consolidated—the operations of its mines and mills—are very different from those that obtain at the Utah plant, and that ores of the Utah containing even eight-tenths of one per cent, with honest and intelligent methods of mining and treatment, and with copper at thirteen or fourteen cents a pound, should afford a fair margin of profit.

And now that the immediate burden of operating this vast property has, by the retirement of Manager Jackling, fallen upon the shoulders of Assistant-manager Gemmel, and in view of the fact that all efforts to market the shares by deceptive methods have failed, the paramount question now is, will Mr. Gemmel be permitted to meet the situation manfashion, and adopt at once intelligent and sane methods of mining and treatment of these vast bodies of misrepresented, but yet commercially valuable ores.

Speaking for Mr. Gemmel personally, we do not hesitate to say that if he fails in this crisis, it will not be because he does not know the only and better way, for he is not only a capable and practical engineer, but, withal, a conscientious and intelligent gentleman.

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In a descriptive article on the mines and prospects of Mason Valley we read that "this vein is a fissure in gray, crystalized lime, which constitutes the hanging wall." Good

THE TARIFF ON LEAD

Our friends of the Commercial Club have permitted themselves to be lashed into a high state of frenzy by a number of well-meaning but grossly misguided and misused gentlemen, who have come to believe that the lead and precious metal-mining industries are greatly imperiled by the reduction in the tariff on lead, proposed by the pending Democratic tariff-revision measure. We beg our friends to possess their souls in patience and to consider in a broad light, and practical sense, what would be the possible and real effect upon these great industries should this measure actually become a law, as in all human probability it will notwithstanding the most strenuous efforts of our friends to the contrary.

The bill provides a duty of half a cent a pound upon the lead contents of ores imported into the United States, which a moment's consideration, we think, will afford ample protection against any possible importation of ores of that character, as any lead brought in in this form would necessarily be involved in a cost of at least one cent a pound before it could be put in condition to compete in the market with lead in pigs and bars. Besides, with no lead coming from British Columbia, and a premium in that country upon its production, and with smelting plants in Mexico which take care of all the production of that region, anything in the form of pigs or any possible importation of stray lots of lead ore may at once be dismissed as negligible in quantity.

In the matter of the importation of lead in pigs and bars, the bill provides an ad valorem tax of twenty-five per cent which, in view of the fact that for years the price of lead had been maintained in this country practically at and above four cents a pound, it will be seen at a glance that the duty would be at least one cent per pound and more; so that no foreign lead could be marketed at less than five cents per pound and to which, of course, must be added costs of transportation, commission, and so forth. Of course, if the price should rise higher in this country, the ratio of the tax would increase proportionately.

Now, in view of the fact that the difference between the price of lead in bars between this and foreign markets has for years ranged at and above one-half cent per pound, and was, during the latter part of last year, and January of this year, one-half cent a pound higher in London than in New York; and in view of the further fact that all lead producers in foreign regions have been greatly depleted, it certainly seems that the proposed rate would afford ample protection to our home producers. In this connection it may be pertinent to observe that the paramount peril to the lead-mining industry of the United States, and the world abroad for that matter, lies in the absolute control of the lead production of the United States and Mexico by the Guggenheims, through the National Lead Company, or lead trust.

It will be remembered that about the time of the meeting of the last Congress, and as notice to their country as to what would happen if there should be any interference by Congress with the tariff on lead, Mr. Daniel Guggenheim, head of the lead trust, from a clear industrial sky, announced a cut of thirty cents per hundred pounds on lead which he followed up by further cuts amounting in all to about sixty cents per hundred pounds, which brought the price in New York to a point about fifty cents below the market in London. If our friends will direct their attention to an investigation of the lead trust, and of the American Smelting & Refining Company, their efforts will have some show of bearing fruit advantageous to the industry they are seeking to conserve.

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J. C. Dick, a local mining engineer formerly in the employ of the Utah Copper Company, returned from a trip to the properties of the Alaska Gold Mines Company a few days ago, and the newspapers were glad to get an expression from such a "disinterested" source. Mr. Dick was quoted as saying that he found conditions even better than has been reported. He found the ledge to be all of 300 feet wide, instead of the seventy feet originally claimed and he also reported that they were getting ore in the Sheep Creek tunnel, also. This would indicate that the "vein" is all of 6300 feet wide instead of 300 and it will aid materially in the tacking on of several hundred million tons of newly developed ore when the management gets ready to make another try to filch a few million dollars from the public. Mr. Dick is a pretty busy man and it was good of him to go up and undertake to clear up the situation and breathe new life into the corpse. But it won't work, Jim! We even doubt if the Guggenheim vultures will attempt to feed on that carcass.

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It is now about a month and half since the Commercial Club decided to undertake a solution of the smoke and fume problem and appointed a special committee for that purpose. If anything has happened since we have not heard of it. The newspapers—beg pardon—the daily press seem to have forgotten all about the "official" investigation demanded a few weeks ago. What's the matter?

Federal Mining Report Shows Up Guggenheims

The report of operations of Federal Mining and Smelting company for the first six months of the present fiscal year (September 1, 1912 to February 28, 1913) signed by its secretary, Mr. Frank Sweeny, and sent to the stockholders, merely emphasizes the extent of the continuous loss sustained by stockholders through its contract with the American Smelting and Refining Company which minority interests are now seeking to annul as fraudulent and which was made when the Federal Company was, as it still is, controlled by the smelting company and when the latter company was in fact both contracting parties.

Assuming the figures in the report are correct and that production has been maintained at last year's average of approximately 10,000 tons of ore and concentrates a month, containing an average, as last year, of 42% lead, it is evident that about 22,680 tons of lead have been produced in six months after allowing usual deduction of 10% for "smelting loss" The average price of lead from September 1, 1912 to February 28, 1913 was $4.614 per 100 lbs. or 23c higher than the average quoted in the company's last annual report.

This does not agree with the statement in the Secretary's report that "earnings were made in spite of the prevailing low price of lead." The report also fails to mention that the average price of silver for the same period was 62.881c per ounce, as compared with 58c recorded in the last annual report. This would account for added earnings of approximately 95c per ton of ore, or roughly $9,500 per month.

But, instead of receiving the price for lead above quoted, the Federal Company, under provisions of its smelting contract, only received $3.94, or 67c per 100 lbs less than the average price of lead, or no less than $5.06 per ton on ore and concentrates shipped. This means that on 60,000 tons produced in the six months covered by the report, the controlling trust has paid for the product shipped it by the Federal Company over $300,000 less than its market value, in addition to taking a smelting charge of $8 per ton, amounting to $480,000. Other producers in the vicinity of the Federal Company enjoy a freight rate to smelting points as low as $6 a ton, but Federal is, by the terms of the contract, to pay a freight rate of $7.15 for the privilege of doing business with the Guggenheims, although the greater portion of the product is shipped to a point where the freight is $2.75 per ton.

Summed up, if Federal enjoyed such a contract as that granted by the same trust to the Hercules Mine (controlled by the family of Harry L Day, president and general manager of Federal, who also draws a salary of $15,000 from stockholders) its six months' earnings would have been $892,600, instead of $520, 000 as reported by Secretary Sweeny. This is at the rate of $1,785,200 a year, or 10% on preferred stock and a surplus of $585,200. Put in another way, if Federal received full value for its lead product, its honest earnings would provide full 7% dividends on its $12,000,000 preferred stock, full 10% on its $6,000,000 common stock and still leave a surplus of $345,000. This does not take into account the juggling of freight rates.

The world's visible supply of lead is running short and there is no question in the mind of any man acquainted with the real situation that, tariff or no tariff, the price will advance materially in the next few years, although it may be artificially depressed for a time by the Guggenheim interests using the bugaboo of the reduction of the tariff for that purpose.

Remembering that this unholy Federal contract has still seventeen years to run, stockholders can easily figure for themselves the extent of the iniquity practiced by the American Smelting and Refining Company, the controlling interest, and the enormous amount of which they will have been deprived at the end of the contract period. Their money is now being used to insure this result. They can also understand the tremendous importance of this contract in its bearing upon the trust's domination of the lead market of the United States.

SIDNEY NORMAN,
On behalf of minority stockholders

In addition to depicting clearly the tremendous losses that the shareholders of the Federal Mining and Smelting Company must sustain for the next seventeen years if the present smelting contract is not annulled, Mr. Norman's letter makes reference to another matter that it would be well for those who are predicting dire disaster in case the tariff on lead is removed by Congress, to think about. The Federal Mining Company is one of the largest lead producers in this country and it is certain that Mr. Norman, as a stockholder in that company, would not make the statement he does above if he thought for a moment there was danger of ruining the lead-producing business by tariff revision, other than through artificial depression of the price by the Guggenheims for political effect. Backed by such outrageous contracts as that being enforced against the Federal Mining Company, the lead smelting trust—the Guggenheims—can well afford to spend some money in playing the political end of the game for the temporary effect it may have, because the producer is made to "pay the freight" anyhow.

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BREAKING THE CAPPING

If steam shovel mining is to be continued at the Utah Copper, we beg to call the attention of the new manager, R. C. Gemmel, to a statement found in Mr. Jackling's report dated January 24, 1908, page 14, in which he says: "THERE ARE SOME ADVANTAGES IN CONTINUING UNDERGROUND MINING OPERATIONS IN SOME PORTIONS OF THE PROPERTY, BECAUSE THE ORE MINED IN THIS WAY IS TAKEN FROM THE OREBODIES LYING DIRECTLY BENEATH THE CAPPING, RESULTING IN THE CAPPING CAVING INTO THE OPEN STOPES AND BREAKING ITSELF, SO THAT IT IS NOT NECESSARY TO BLAST IT FOR STEAM SHOVELING."

The great advantage of the method mentioned by Mr. Jackling (in that it avoids the very great expense which would otherwise be involved in the drilling, and blasting the capping with powder) will doubtless be apparent to Manager Gemmel. We simply call the attention of Mr. Gemmel to ex-Manager Jackling's wise method of breaking down capping in order to justify the suggestion that, inasmuch as the ore has been—by underground mining methods—entirely removed from the property on the east side of the canyon, and the caving in and breaking up of the capping in that entire area having been completed, rendering it in the highest degree susceptible of removal by steam shovels, that the shovels now operating on the west side of the canyon, preparatory to securing ore, (and which work is attended with great expense in breaking down capping by blasting) be removed to the east side where the ground already is prepared in a manner to afford the advantages in steam shoveling

contemplated in the statement of Manager Jackling. In the meantime, underground working could be pushed on the west side until the capping there would be compelled to break itself in the open stopes, preparatory to future steam shovel mining operations.

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SWAMPED BY TAILINGS

When locating the proposed site for the great Garfield-Magna, Utah Copper, concentrating plants, the ground was visited by the directors and others interested in the property and some mild criticism was offered by a member of the party concerning the flat character of the ground selected by Mr. Jackling, on which the proposed structure was to be erected. Vice-president Wall suggested that the mill be placed on the side of the mountain, one or two hundred feet higher, in order to secure the advantage of gravity in handling the ores through the mill, and also to insure ample dump room for the deposition of the enormous quantity of tailings which would result from the treatment of the ores of the great deposit, and to which Mr. Jackling replied: "I want to build my mill on level ground, and I would rather pump my tailings than pump my water." It now appears that the accumulation of tailings has been such as to already encroach upon the railroad used for removing the concentrates from the plant, and they even threaten to engulf the lower floors of the mill. To avoid this calamity it appears that large quantities of stripping material is being hauled from the mines, over the Bingham & Garfield Railroad, and dumped so as to form a levee, or dyke, between the mill and the railroad tracks, and thus check the encroachment of the tailings. In this connection we beg to suggest to Manager Gemmel that he adopt the wise suggestion of Manager Jackling and at once install a series of units of sand pumps in order to turn the tide of tailings in the direction of Great Salt Lake. We recommend that the units be so placed as to permit the addition of other units as the capacity of the mill may be enlarged to meet the ever-increasing volume of ore at the mines.

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CHINO DIVIDEND IN PARIS

It is little wonder that the Frenchmen have recently been hurling back to America the Chino shares they were inveigled into buying in the belief that the company was on a dividend-paying basis. The scheme worked upon them was, according to the following, from the New York Times Annalist of Monday, April 14, a fine example of sharp practice—to be charitable in expression—and it illustrates perfectly to what extent the company's sponsers in this country will go in order to find a market on which to unload. Just think of a company representing itself as being on a dividend basis abroad months ahead of the time when it begins PROMISING to pay at home. But let the Annalist explain to you how the "shell game" has been manipulated:

On Feb. 10 The Annalist printed in its Paris cable a statement to the effect that the Chino Copper Company was expected either to reduce or discontinue the dividend on its stock. This, the Paris correspondent said, was the reason for the weakness of the Chino shares on the Paris market that week.

Various adept writers on mining topics in New York and Boston made sport of this news, and asked if it could be true that neither the mining editor nor the Paris correspondent of The Annalist knew that Chino Copper stock never paid a dividend. The Boston News Bureau commented disagreeably upon what it assumed to be a journalistic blunder, said it was a brilliant example of going away from home to get the news, and indignantly called upon The Annalist to dismiss the misinformed Paris correspondent.

It will, therefore, be news to all of them that Chino Copper has been regarded in Paris as a dividend-paying stock from the beginning, has always been quoted as such on the Exchanges, and made at the outset a distribution which every one was led to call a dividend.

That is to say, on the introduction of Chino Copper to the Paris market the first buyers cashed a premium of 1.25 francs per five-dollar share. Thereafter the shares were officially quoted as "Coupon No. 1 stamped for installment dividend paid," or "Coupon No. 1 detached."

On March 3, which was nearly a month later than the Paris correspondent's cable to The Annalist, the following paragraph of information appeared in the financial columns of the Paris papers:

"The Directors of Chino Copper have postponed the declaration of their dividend. This step was rendered necessary by the inability of the company to meet the amount of the dividend coupon, having insufficient funds for that purpose, in consequence of having been unable to market its entire output of copper."

On March 20, Le Globe, in one of its financial paragraphs, called attention to the fact that a dividend rumor about Ray Copper had failed to affect the stocks favorably and surmised that people were too easily reminded of what had happened in Chino Copper, where, after having led every one to expect a dividend, the company deferred the payment thereon. Although the Chino shares dealt in in Paris and here are identical in every other respect, those dealt in in Paris were from the beginning referred to as dividend-paying shares. It was perhaps intended that they should be so regarded.

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J. M. Bruce is the name of the man who has been sent out from the Missouri lead-zinc mines to take charge at the Butte & Superior and see what he can do with it. Eastern "financial" papers (spare the name) state that Mr. Bruce relieves Max Atwater—which he don't. He relieves Allan H. Rodgers, who is reported to have become so disgusted with the entire Utah Copper crowd and its methods of "cooking things up" that he could not, and would not, stand for it any longer. We do not know Mr. Bruce, but our heartfelt sympathies go out to him.

DALY WEST LEAD RECOVERIES

The Salt Lake Mining Review of March 30 contains the following editorial paragraph:

Mill Superintendent Sherman, of the Daly West Mining Company, operating in the Park City district of this State, reports that the actual saving in lead values for the past fiscal year was 98.7 per cent. To the best of our knowledge, this is a most unheard of recovery in the milling of lead ores, and has never been equaled or approached.

The writer's memory is either failing or else he has not paid much attention to the contents of Daly West annual reports. The record mentioned is so commonplace at the Daly West as to have long since ceased to cause even passing comment. In December, 1909, in an article dealing with the merging maneuvering of the Daly West company, we took occasion to show what a perfect master of the business of ore concentration Mr. Sherman was, and among other things said:

These statements show that at no time during a period of several years has the recovery of the lead contents of the ore fallen as low as 98% and seldom below 99½%. The mill superintendent's report for 1908, page 12, says: "The average assay value of the tailings was 0.02 of 1% Pb. (meaning lead), * * * while the actual saving, based on the value of the concentrates sold, was 99.8% of the Pb.," or lead contents of the ore.

To illustrate the extraordinary character of this work, the report states that "original contents of lead in the ore was 4.71%," equal to 94.2 lb. per ton of ore, of which 94.01 lb. were recovered, the loss being a little less than 0.19 of a pound, or about three ounces of lead per ton of ore treated—barely enough to supply a single charge of a shotgun.

And such statements as these have been annually handed to stockholders by the management for several years past. At the same time from three to five groups of men, averaging in all probably twelve men daily, working with the most crude appliances, have been constantly engaged collecting and rewashing the tailings as they flow down the canyon from the company's mill, and all are said to make wages ranging from $3 to $8 per man per day—and all this derived exclusively from a recovery of portions of the three ounces of lead per ton shown by the official reports of the company to have been lost in the concentration of its ores.

These results appear all the more remarkable when it is understood that when the company's mill was operated at full capacity the loss of lead (Pb. as the mill superintendent puts it) did not exceed 75 lb. per day, and worth, less standard deductions, about $1.60. From all of which it must be inferred that those technically untrained gleaners of the tail-race, with the primitive methods employed, have surpassed in efficiency the most modern appliances of the age—or that the management is indulging in coarse deception.

And we might add that the working over of the tailings from the creek below the mill is still (in season) carried on presumably just as profitably as ever. And it may be observed that one of the leasers during all this time,—and at the present,—has paid and continues to pay $50 per month for the privilege of operating his primitive machines upon lands owned by others, over a portion of which the tailings flow, after having been discharged from the company's mill. It may also be added that this operator is at the head of the line of the retreating plants.

Guggenheims Want $15,000,000 from Public

The announcement that the Guggenheims are preparing to offer the investing public an opportunity to supply the needed capital for the recently organized Chuquicamata Copper Company of Chile, S. A., is worthy of more than passing notice, inasmuch as the plan of financing the proposition is in strict keeping with the practice of these promoters in all similar projects with which they have had to do in the past.

The new company will absorb the mining properties formerly owned, and partially developed, by the Chilian Exploration Company. The capitalization of the new company is stated to be $110,000,000, divided into $25 shares. Of this capital stock $15,000,000 will be held for the conversion, at par, of a $15,000,000 convertible bond issue bearing interest at 7% annually. The remainder of the capital stock, $95,000,000, will be retained by the Guggenheims and affiliated interests. Only the convertible bond issue will be offered the investing public for subscription

This proposed $15,000,000 bond issue will afford the sponsors of the project a return of their original expenditure of $2,500,000, and, after setting aside the $7,000,000 said to be necessary for mill and other equipment purposes, will provide a cash reserve of $5,500,000. Thus it will be seen that the Guggenheims do not for a minute contemplate a direct investment for themselves. What they have accomplished in past instances is evidently proposed in the present flotation. The initial expenditure (absolutely in the nature of a temporary loan) of $2,500,000 was made only for the purpose of preparing the property for financing, and not as an investment. The main object throughout has been to exploit the property, then finance it with money furnished by the investing public (which financing would return the amount of the temporary expenditure, in adidtion to tremendous profits resulting from stock-market manipulations), and to retain control of the property without having directly invested a dollar. The plan proposed, if carefully studied, will make the matter clear.

To those conversant with the physical operation of large properties the capital requirements of even $15,000,000 which it is hoped the public will supply is excessive, considering the extent and operation of the property. To others, dealing exclusively in stock market matters, regardless of the ultimate liquidated value of the stock based upon physical operations of the mining property, the relative proportions of the stock issue retained by the promoters to that offered the investing public, clearly indicates the trend of affairs.

It is claimed by the promoters of the new Chuquicamata company that there has been developed to date, approximately 100,000,000 tons of copper ore having an average content per ton of 1.75 to 2.0 per ton copper. Although a considerable area of mineralized ground was partially developed by means of the earlier mine-workings, which have been a source of information to the engineers in charge of the development work, the aggregate ore exposures therein would represent but a fractional part of the total prospecting necessary to develop the tonnage of ore claimed by the promoters, inasmuch as the older workings were mainly superficial. Eliminating that factor in the development it will be interest to note that six Star traction-drills now have been in operation on the property for about a year churn-drilling the orebody. During the year's operations the drills have been actually operated only about fifty per cent of the time, due to climatic conditions and difficulty in drilling resulting from the peculiar structural relation of the rocks due to the extensive faulting. In view of these circumstances the declared development of 100,000,000 tons of ore in six months is questionable, as also is the claimed general average grade of the ore.

By the leaching process which it is understood the management intends to use in the treatment of the Chuquicamata ores, it is claimed that a 90 per cent extarction of the copper content will be effected, but no statement of cost per pound of refined metal is given.

Regardless of whether a profit is made on the Chuquicamata operations or not, the Guggenheims will be fully recompensed, financially, for their efforts in promoting the new company. This will be accomplished in part, through the plan of financing the property as hereinbefore outlined, and later through arrangements that will tie up the Chuquicamata company in a smelting, refining, and selling contract Ample evidence along that line is available from the history of the Utah Copper, Chino Copper, Ray Consolidated, and more recently, (as outlined elsewhere in this issue by Mr. Sidney Norman, representing the minority stockholders) of the Federal Mining & Smelting Company, all of which have been tied up on long term smelting contracts affording the Guggenheim interests outrageous profits as compared with what might have been obtained in a competitive market.

Of course, in order to acquire these contracts it has been necessary at times for the Guggenheims to consider investments in the respective companies securities, but, relatively speaking, the term of contract together with the excessive charges imposed on the individual company under the agreement, permitted an ultimate capital return to the Guggenheims far in excess of the initial investment in company securities, which latter oftentimes were sold in the open market at a favorable profit, and in no instance at a loss. Therefore, it will be noted that investments in the securtities of other companies by the Guggenheims is merely a means to an end. Having secured a long-term refining and selling contract, an investment on their part directly in the mining or milling enterprise is unnecessary, for the very apparent reason that through holding that agreement, indirectly they control the proposition.

Aside from the other circumstances surrounding the control of the Chuquicamata project as hereinbefore noted, the probability is that the new plant will not produce refined electrolytic copper but rather a precipitate which will require refining at one of the Guggenheim smelteries—under a contract which will afford practically the entire profit of operations to them. When such an agreement is consummated (provided there shall be any product to treat) the Guggenheims then can withdraw from the company by gradually disposing of their share of the remaining $95,000,000 capital stock to the public, and still continue in control of the property, as theretofore, through the medium of the smelting and selling contract. Even though the property should succeed in maintaining operating expenses only, insofar as the mining and milling operations are concerned, the increment derived on the smelting, refining, and marketing of the product would amount to many millions of dollars during the life of the property.

Thus, assuming the ore tonnage developed (100,000,000), average copper conten (2.0% maximum), percentage recovery, (90%) and other managerial statements to be correct, then, if we should assume the treatment of 7,000 tons of ore daily as the capacity of the mill, and an allowance of ten per cent loss in smelting and refining, the life of the property would be forty years. During that period, on a copper metal production totaling 3,240,000,000 pounds, and allowing a minimum profit to the Guggenheims under their usual "contract" of 1.75 cents per pound of refined, market-

ed metal, their profit would represent $56,700,000, or at the rate of $1,417,500 annually. This amount, added to the sale of 50 per cent of the $95,000,000 of stock in the company that remains after bond conversion provisions, would afford a yield of $47,500,000, making a grand total rake-off of $104,200,000 for the Guggenheims, without a dollar's expenditure or one cent of risk on their part.

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AN HONEST ANNUAL REPORT

The annual report of the Phelps-Dodge company for the year ended December 31st, 1912, made its appearance on the first of the present month. It is a model of concise, truthful information and as such we commend it to the mining and ore reduction companies which apparently strive as hard to deceive shareholders as this company does to let the world know just what it is doing. A careful perusal of the several balance sheets clearly illustrate the practice of the management in the presentation of facts. Each report is complete and in detail, so that the distribution of accounts is not difficult to follow. Of particular interest is the manner in which the management cares for the amortization of its several properties. Renewal funds are carried as they should be, and the annual depreciation on plants and mining properties is lucidly presented. The valuation placed upon the mining and reduction properties is evidently conservative, and at no point is there to be found any deviation from a conservative and straightforward policy of publicity.

The company owns important mercantile establishments at its various mining, milling, and smelting points. In these, primarily, the object sought is to afford employees an opportunity to purchase merchandise at a small profit over actual cost. This feature is best illustrated from the fact that, during the year 1912 the gross sales amounted to $6,321,410.86, on which a profit of but 9.12 per cent was earned.

During the year the quantity of copper delivered was 192 297,374 pounds, of which 98,267.037 pounds were sold to domestic, and 94,030,337 pounds to foreign trade. The average price realized on sales for the year was 15.51 cents a pound, net cash, f. o. b. New York.

On the basis of its issued capital of $45,000,000, dividends amounting to $6,750 000 were paid during the year, or at the rate of fifteen per cent for the year. This was occasioned by the payment of two extra dividends (one of 2 per cent at the end of June, and another of 3 per cent at the end of December) in addition to the usual quarterly dividend of 2.5 per cent. The financial statement also indicates a substantial reserve fund against stocks owned, as also a satisfactory surplus account.

The subsidiary companies of the Phelps-Dodge interests are: The Copper Queen Consolidated Mining Company, Detroit Mining Company of Arizona, Moctezuma Copper Company, Burro Mountain Copper Company, Stag Canon Fuel Company, and the Phelps, Dodge Mercantile Company.

During the year the total copper ore extracted from the company mines amounted to 1,983,244 tons of which quantity 1,098 528 tons were concentrated, and 794,716 tons smelted directly. The total amount of copper bearing material smelted, including ores, concentrates, old slag, and cement copper, amounted to 1,051,315 tons. In addition to the above there was produced, and sold, 11,626 tons of lead ore from the Copper Queen mines, yielding 30.434 pounds of copper, 2,953,685 pounds lead, 326,962 ounces silver, and 3,889 ounces gold. Of the total ores and concentrates smelted 953,741 tons were derived from the company properties and 97,574 tons were purchased.

The Copper Queen smelting department report, covering the operation of that department, states that there was treated on the entire plant, 1,151,949 tons of charge, of which 884,814 tons were smelting ore, 73,720 tons were silicious ore for the converters, and 193,415 tons composed of converter and furnace secondaries. The bullion produced was 124,915,708 pounds.

It is stated that a great reduction in the amount of flue dust was effected when the fumes from the converter were deflected from the cupola dust chambers, and a still greater reduction when the reverberatory plant started up, and the fines sent to that department. It dropped from a maximum of 8.87 per cent per ton of charge in the month of June to 2.72 per cent per ton of charge in the month of December.

In April, 1912, a change was made from the old acid process to the new basic process of converting matte. Two stands of the Great Falls type of basic lined converters were placed in commission toward the end of the year, and the remainder of the old-style barrel-shaped converters will be replaced by Great Falls type converters as soon as practicable.

The report of the Detroit Copper concentrator operations is outlined in the following table:

	Assaying % Copper
Ore concentrated, 501,928 tons...	3.08
Concentrates produced, 70,428 tons	16.69
Savings:	
Ore and concentrate	76.12
Ore and tailing	77.34
Concentrate and tailing	77.06
Assays only	77.43
Tailing assay	0.811
Tons ore milled per ton concentrate	7.1 to 1.
Actual percentage running time to total time	95.11
Tons ore milled per 24 hours actual running time	1441.8
Gallons water used per ton ore milled	511.2

The detailed report given above is noteworthy for its brevity and correctness. For example, the methods employed in the calculation of the general average percentage recovery of copper mineral from the material is important. Note that the per cent variation between the highest stated average percentage recovery (77.43%) and the actual operating results (76.12%) affords a difference of less than 1.5 per cent. This method of determining the percentage recovery is commendable, and should be more generally employed by other large mills; in fact, it is the only correct means of determining absolute results, and precludes the padding of operating reports. Other equally important factors are the presentation of the facts governing the actual period of operation through the year, and the average daily tonnage for the year.

The Detroit smeltery blast furnace and converter operations show the treatment of 173,266.8 tons of material from which there was produced 24,802,789 pounds of copper bullion. The general average percentage recovery in smelting and converting for the year is stated as 93.863 per cent.

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The mining fraternity generally will be glad to know that Prof. Chas. E. van Barneveld, has accepted appointment as chief of the department of mines and metallurgy of the Panama-Pacific International Exposition and that he will be at his desk, Exposition headquarters in San Francisco, on May 1. For the past fourteen years the professor has been at the head of the mining department of the Minnesota School of Mines. Previous to that he spent six years in general mining practice in Colorado, the Southwest, Mexico and Canada. The professor is a graduate of McGill University, Montreal, Canada, and enjoys a wide circle of friends in the mining and metallurgical world.

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Copper production of Peru in 1912 was 27,400 long tons as against 26,000 in 1911.

PASSING OF TWO NOTABLE CHARACTERS

Developments of Past Month Bring to Mind Recollections of Methods Employed to Create Booms and Manufacture Mining Engineers and Magnates.

During the closing hours of the stormy month of March, and within four days thereafter, the passing of two notable characters was announced. The first, Joseph T. Jenkins, for many years mining editor of the Salt Lake Tribune and the Intermountain-Republican, passed to the Great Beyond. Mr. Jenkins possessed signal ability as a newspaper writer, and had many traits of character which, had they been differently directed, would have made him an enviable name. But let us draw the mantle of charity over evidences of his short comings, and join with those who knew him, in saying: Poor "Joe;" peace to his ashes.

On the evening and night of the fourth day of April, following the event recorded above, the young "multi-millionaire" mining magnate, Daniel C. Jackling, whose portrait is presented at the head of this column, was guest of honor at a banquet given at the Alta Club for the purpose of celebrating the unparalleled success of his numerous exploitations, and to say "good-bye, Jack," on his retirement from this field of his former activities.

Before proceeding with further discussion of the operations of this brilliant young millionaire in this and neighboring fields let us revert to the earlier history of speculative manipulation which resulted from the impluse given by the facile pen of the late Mining Editor Jenkins; because it was to his persistent energies along the chosen line that the eminent engineering skill, and managerial ability, attributed to Mr. Jackling, as well as the success of the various enterprises with which his name was connected, was due almost wholly to the efforts of Mr. Jenkins And yet withal, we are advised that he was permitted to die in comparative poverty. In order to show how the speculative appetite of communities involving vast financial interests was worked up—in which Mr. Jenkins played a leading role—we can do no better than reproduce the following article from the Bingham Bulletin of Friday, February 24th, 1905:

There was a time, not very long ago when the mining editor of the Salt Lake Tribune was confidently eagerly awaited each morning for the latest and most reliable information upon all matters pertaining to the new life upon which the mining industry had just entered. The accidental discovery by the Wilson brothers, of a large body of lead ores upon the old and long-abandoned [illegible] of Park City, led to the development of the enormous bodies of rich silver-lead ores of the Mayflower and Silver King. "Old [illegible]" [illegible] than twenty years since the closing of Sparrow-Hawk mine and mill by Captain Shaw and the English owners, had suddenly been aroused to new life by the discovery of gold in paying quantities in the carboniferous shales that extend over vast areas of that district, and which for a time promised to rival in extent and richness the "Rand" of South Africa, with which it was compared in many material characteristics; likewise the old camp of Ophir, whose low grade ores had slept for even a longer period of time, was, by the application of modern skill and improved methods, in the midst of a season of unprecedented prosperity. At Tintic the "Grand Central" and the "Uncle Sam" had suddenly burst into prominence by reason of discoveries of large bodies of high grade ores, in hitherto undeveloped portions of that erstwhile quiet camp. Even the lease-worn camp of Bingham had experienced a new birth, due to the accidental discovery of vast bodies of copper sulphides in the Highland Boy mine, following the usual disappointments which result from efforts to extract gold from rocks wherein none is contained.

The slump in the silver market and incidental paralysis of dependent industries due, in large measure, to the hostile attitude of the last Cleveland administration, had driven the restless miners to search anew abandoned "stopes" which marked the former hiding place of valuable ore bodies, and to pursue to greater depth the faded evidences of pre-existing wealth, with the result that every old "camp" could now boast of one or more old mines [illegible] and many new and promising discoveries made in hitherto undeveloped grounds. The precious metal contents in many instances was found to be in diminished proportion, and base and refractory substances had intruded instead, but improvement in metallurgical knowledge and mechanical skill had kept pace with emergency. Meanwhile the people had acquired habits of economy and thrift and many had laid by hordes of comfortable proportions, and were eagerly looking forward to some favorable opportunity of investment which promised quick and profitable returns.

A great "mining boom" was on in earnest and the air was laden with reports of reputed great strikes. Dreams of sudden wealth haunted every household. A mining and stock exchange became the necessity of the hour, that the widow's mite, the banker's horde, and the gambler's "wad" might have ready opportunity to invest in the representatives of the new-born wealth. Then it was that the Genius who presided over the mining news of the daily paper became and was a real autocrat. He stood between the investor and the vendor, and by coloring or distorting the facts, had it in his power to make or dissipate the hope and fortune of either with the stroke of his pen. How important was it then that this department of the daily paper should be administered by a capable, conscientious and honest person.

The Salt Lake Tribune, having always been the friend and organ of the mining industry, easily maintained the lead as the dispenser of what was believed to be the latest and most reliable news in all that pertained to that field of enterprise.

New corporations, holding out glittering promises, sprang into existence with bewildering frequency until the list upon the daily call-board of the Salt Lake Mining and Stock Exchange numbered nearly one hundred. True, but few of the producing mines were included in the list. The real value of their shares was too high for the purse of the small investor, who demanded a large number of shares for a small sum of money. They argued that the producing mine had sprung from a prospect hole and all remembered when the shares of the Silver King were almost as cheap as the meanest on the list. Then why not all those become great mines also? And this thought received daily encouragement not only from the promoters of various wildcat schemes, but from the daily press, and especially the Salt Lake Tribune, whose mining columns teemed with fabulous stories of "strikes" upon claims which had never felt the impress of the miner's pick, and of promised early dividends from others upon which not a pound of marketable ore was ever known to exist. And thus was the public appetite whetted from day to day; speculation was at fever heat; transactions upon the stock exchange reaching scores of thousands was of daily occurrence. Meanwhile the real mines continued to pour the result of their riches into the public lap, which made it all the more easy to maintain the delusive speculative interest in the "wildcats." And this condition continued with little abatement of interest for some three years, during which time probably two millions of dollars were drawn from the meagre earnings of clerks, servants, teachers, laborers, and small merchants, and dumped into the stock market in exchange for shares that never possessed intrinsic merit equal to the value of the pulp of which the paper was composed. And all this made possible chiefly through abuse of the power and prestige of the Salt Lake Tribune by the trusted editor of its mining columns.

Did this editor profit by the waste of other people's money which he caused? "It is said" that he did to the extent of at least $40,000; but, "it is also said," that finding accumulations too slow, he entered the brokerage firm of Higginbotham & Company in order that he might be in position to anticipate advances in the share market which were sure to follow the publication of manufactured falsehoods pretending to disclose inside news of daily "strikes" in the "matchless" Tomcat mines.

But, "it is further said" that the scheme proved unprofitable, in fact, disastrous, for it appears that the active members of the firm had not been let into the secret (whereby "strikes" seemed to be always on tap, just at the proper moment, to enable the firm to make clever turn

before less favored brokers could 'catch on,") and therefore they were naturally disposed to regard as serious, everything which appeared in the Tribune. Thus it happened, "it is said," one fateful morning that a "manuscript" recording a phenomenally rich strike in the "Peerless Tomcat," and designed as a "double header" for the mining columns of the Tribune the following morning, had been left on the desk of the versatile partner in the back room of the office where it was prepared. The Tribune appeared as usual, but contained no news of the "stupendous" strike in the sky levels of the Master Tomcat mine. In fact, there was no mining news whatever that morning. The voluble editor-partner failed to appear at the usual hour. Of course, he must be sick; he was not very strong at best and was subject to sudden attacks which frequently caused his absence for days and sometimes weeks, but he always came back smiling and there was no cause to fear this time. But how fortunate that the public had not caught on to news of the strike, thus reasoned the remaining member of the firm of Higginbotham. Then they went forth and loaded up with the shares of the Tomcat mine until the firm's entire cash balance was exhausted, and then some more; but this was a fatal error. The public never learned of the "strike" and therefore, refused to buy the shares of the famous feline; thereupon the firm failed and "it is said" the strike editor of the Tribune dropped his "wad," whatever that may mean.

In the progress of time the more wealthy class of people became infected with the speculative stock-gambling craze, so that there was demand for higher class securities, and transactions involving large blocks of shares in dividend paying mines were of frequent daily occurrence. But the want was not "long felt." The Uncle Sam mine at Tintic which had produced several hundred thousand dollars worth of valuable ore under the individual ownership of "Uncle Jesse" Knight, was for sale on the "quiet." True, it was not producing at that time, because, as the sequel showed, it had been gutted of every ton of known marketable ore. But this fact was not known, or suspected, by the stock-buying public; besides, "Uncle Jesse" was a peculiarly eccentric man and had often been heard to say, when asked why he did not continue to mine and market the vast bodies of rich ore therein exposed, "that the money was safer in the mine than in the banks, and as he was not in immediate need of money he preferred to keep the mine closed."

Having secured the necessary authority, Hon. Dave Evans opened subscriptions to shares in the "Uncle Sam Mining Company," a corporation to be formed which would take over the Uncle Sam mine. There were to be 500,000 shares, and the subscription price was one dollar per share. Only a selected few were let into the deal at first, and in an incredibly short time it was announced that the shares had been over subscribed many thousands; whereupon the Tribune began an incessant fusillade of falsehoods, picturing in nauseous terms "stupendous ore reserves" which only awaited the magic touch of the new corporations to convert them into immediate dividends. And thus, even before the new shares could be printed, the price had been forced above $2.00 per share, so eager were the investors to secure a small holding in this bewitching venture. Ten thousand shares had been discreetly placed at the disposal of the Tribune staff, of which 6,000 shares were retained by Mr. Lannan, 1,000 was awarded to———, and the remaining 3,000 shares to the editor of the mining department of the paper. J. S. Daveler, foreman of the printing department, was ignored in the division of the spoils, and therefore "gave the snap" away.

The success of this fraud prepared the way for the perpetration of another, even more glaring, along the same lines, and so the "Carisa," another worked out bonanza, was put out with the same number of shares, subscription price, $1.25 per share. This was likewise over subscribed, whereupon the price advanced to $1.60 before the shares were delivered. The Tribune's efforts to secure higher prices having been even more vigorous than in the cause of the Uncle Sam, and it is said the mining editor's allotment consisted of a like number of shares. Then came another companion piece and neighbor, the "Yankee," the career of which was phenomenal. Within the space of a few weeks its shares had been rushed from about ten cents, which was too high, to over $5.00, the mining editor being credited with a net profit—for his "influence" of over $10,000. The "Chloride Point," near Mercur, under the chaperonage of "Parson" Tibbals, with the promise of early dividends, persistently urged by the Tribune, found ready sale at $1.30 per share upon a capitalization of 400,000 shares. This proved a dumping ground for the savings of the teachers in the various public schools, and even ministers of the gospel are said to have yielded to the temptation to get rich quick. The intrinsic value of these shares was never a measurable quantity.

By the same methods the Northern Light, adjoining the Chloride Point, with 400,000 shares, had been pushed from nothing, its true value, to $1.50 per share. The "Daisy," worth nothing, to 65 cents at and near which price the whole bunch of 300,000 shares were unloaded upon the public. The list of worthless stuff located at various points throughout the state might be extended indefinitely, but space and time forbids. One special case we have in mind, however, should not be passed over. It is the California mine, near Park City. This property was being developed in a vigorous and systematic manner, and for a time gave promise of real merit; but the owners apparently became tired of the long wait for legitimate results and so determined to reach the goal by a short cut. The services of the Tribune were enlisted and soon a substantial boom in the share market was an accomplished fact. The price of shares rapidly advanced from a few cents to nearly $3.00 per share. Upon a morning following a certain day on which the highest recorded price of sales on the exchange was $1.45, the Tribune announced the purchase at private sale by McCornick of 15,000 shares of California stock at $1.75 per share, or thirty cents a share above the market. Of course, there was not a word of truth in the statement, but it had the desired effect. The market price almost immediately passed the $1.75 point supposed to have been set by McCornick.

At this juncture poor old Ben Sprenger, an ex-member of the Exchange, planked down $1,750 in gold in exchange for 1,000 shares of California stock. The mystery in the transaction was, where did he get the money? for he was known to have been broke for months. The last $2,000 he possessed he had given to his invalid wife for safe keeping lest it be lost in wild speculation as other thousands had before. But there was nothing strange in the matter after all. Having read in the Tribune of the latest strike, and how McCornick was buying the shares without regard to price, it was easy to convince his sick wife that great profit would result from investment of the "sick fund" in California shares, and so it was done.

Mrs. Sprenger died soon after, but not until she had seen the price of California quoted at less than ten cents. Poor soul, she seemed to lose interest in life, and her strength failed rapidly after those precious gold pieces had been carried to the dumping ground. As to the mining editor, he has not been well, either, of late, but occasionally returns to his post long enough to announce some of the more important strikes made in the numerous properties of the United States Mining Company, and to examine the market list so as to be prepared to realize on those 400 shares in case the price should at any time exceed $26.50 per share.

Following the publication of the foregoing article Mr. Jenkins was retired from the service of the Tribune. But soon thereafter, on the establishment of the Intermountain-Republican, he was given full charge of the mining department of that paper.

About this time, Charles M. MacNeill, and others, in whose employ Mr. Jackling was then engaged as foreman of their smelting enterprises in the State of Colorado, secured control of the property which thereafter became known as the Utah Copper Company's mines at Bingham, of which Mr. Jackling was made manager. Up to this time Mr. Jackling had had no technical training, or practical experience in the operation of mines of any character, nor in the treatment of ores by any process, other than that of smelting, (which he gained during his Colorado employment) and of roasting ores preparatory to the application of the leaching process while in the employ of Capt. J. R. De Lamar, under the management of Mr. H. A. Cohen, at Mercur in this state.

The negotiations for the sale of the control of the property to MacNeill and others were conducted by Mr. Cohen under an option held from the then owner, in which negotiations he was materially assisted by Mr. Jackling, who then, as now, because of his genial social qualities, was held in high esteem by Mr. McNeill and associates. For this service Mr. Cohen's commission, amounting to about twenty-five thousand shares of Utah Copper stock, was divided equally with Mr. Jackling in addition to which the former owner, Col. Wall, added in cash $5,000.

Now it appears that Mr. Jenkins, for some reason, was not friendly to Col. Wall, and that some time after the exploitation of the property began under Mr Jackling, relations between Wall and Jackling became somewhat strained, because of Wall's disapproval of Jackling's method of equipping and operating the mine. This, together with Jenkins' well-known propensity to magnify and laud everything done by each incoming new mine captain, afforded ample excuse for the exercise of his accustomed journalistic methods to at once begin the task of making a great mine magnate of Manager Jackling, and at the same time discrediting and disparaging the presumptions of Col. Wall—who was yet the largest individual owner in the property wherein he had from time to time expressed disagreement with the manager's operating methods. This, of course, was assumed to be pleasing to Mr. Jackling; at least, it resulted in special consideration being awarded at all times to Mr. Jenkins. And so the work of building up a great engineer and a great mine began, and so it continued from day to day, ad nauseum, until the columns of the mining department of the Intermountain-Republican teemed with effusive utterances magnifying every blundering movement and act of the manager in his abortive attempts to develop and equip the mines.

Mr. Jenkins had been frequently heard to remark jocularly that during his newspaper experience in Colorado he had made some sixty odd colonels of men

of all grades of character and avocation, who had accidentally or otherwise, been the recipients of any considearble sums of money, derived from mine strikes or the sale of stocks. Of course the same tactics were pursued in his journalistic work in this case, where the crop of military-titled gentlemen, whose promotion was also due to the pen of Mr. Jenkins, was very considerable. Prominent among these earlier operators were Colonel O. P. Posey, Colonel E. C. Loose and Colonel Samuel Samuel Newhouse, whose photographs together with fulsome and extravagant comments upon his many achievements, including the notorious promotion of the Newhouse Mines, before its final slump, almost daily cumbered the columns of the mining department of the Intermountain-Republican.

One of the first reportorial acts of Mr. Jenkins after the installation of Mr. Jackling as manager of the Utah Copper mines, was to confer upon him the favored distinction of Colonel. Following this the development of the Utah properties by new and startling methods and the construction of reduction plants of stupendous proportions at once became the marvel of the mining age, whilst the advancement of manager Jackling to the highest pinnacle of enginering skill and ability was swift and dazzling; in fact, he became a veritable mascotte. The ores upon which this fabric was based were new to the engineer, as well as the ordinary mine operator and miner. The copper tenor of the rock was low, while the quantity was inexhaustible; but nothing short of magic could convert the contents of this strange ore into a commercial product. And although many thousands of dollars had been expended on this property in the driving of drifts, all in ore, and in the testing out along well-known lines of economical and practical methods the best process for the recovery of its valuable contents—and the publication of these facts in technical and other journals—the result of which was the convincing element which induced the Colorado capitalists to invest their money therein, no mention was ever made of former exploitations or knowledge even of the existence of these remarkable ores in the publicity campaign which had been thus inaugurated. In order that the acts of this new champion of engineering miracles might not be dimmed by the works of others, the great mass of new-born earth was simply referred to as the Bingham porphyries, and this, together with the masterful acts of the manager, was followed by such persistence and frequency that the speculative mining world was made to almost believe that the genesis of the rock mass itself was the handiwork of Manager Jackling.

The scramble for the shares of the corporation which ensued soon caused the price to reach dazzling heights. Attracted by the prowess of this wonderful genius, and the commercial possibilities that underlaid the scheme, the Guggenheims were not slow in securing a controlling interest therein, together with a contract for smelting the product of the mines for a period of twenty-five years, and at a rate of three dollars per ton in excess of that ordinarily charged for treating such ores at that time, being equal to an additional profit of nearly one cent a pound on all copper produced. They were enabled to secure this very favorable contract because of the fact that Mr. MacNeill, and the other promoters of the enterprise, had become convinced, upon the advice and persuasion of Manager Jackling, that the property could never be operated in such manner as to produce any legitimate profit, and that they must look to the marketing of shares for future benefits. This conclusion seemed to be justified by the fact that, prior to the advent of the Guggenheims, the Copperton mill, which had a capacity of about 700 tons per day, had been constructed and in actual operation upon the selected ores from the property for about seven months, the results of which were such as to confirm the conclusions of Manager Jackling that all hope of a working profit was futile, the cost of copper produced thereby being in excess of fifteen cents per pound.

In the light of this demonstration the manager had disposed of practically all of his share holdings, much of it at a very low figure, 6,500 shares being given in exchange for a house and lot on Brigham street in this city, worth, at the time, and now, not over $18,000. But the Colorado capitalists were adepts at promotion, and for such purposes knew the value of association with the Guggenheims at that time. It was easy, therefore, for these shrewd practical operators to sense the fact that at least operating costs could be drawn from the ores and thus the smelting contract would become a valuable asset of the family. The purchase, however, was coupled with a loan of $3,000,000, secured by bonds convertible into shares of the company at $20. A further condition of the smelting contract, however, was consent to an agreement that Mr. Jackling would be retained at will as manager of the company. This they readily acceded to, because of the market value of his remarkable reputation as a construction and mining engineer which had been built up by the press, as before indicated.

It may be here observed that the touch of the Guggenheims in connection with the flotation of any mining enterprise was, at that time, magical, so much so that no question was asked by intending purchasers, as to the intrinsic merit of the shares of any corporation with which their names were associated; and it was, and still is, their habit to buy a block of shares in a corporation which controls a meritorious property in order, first, to secure a favorable smelting contract, and then dispose of their purchase to incoming investors attracted by their association therewith. In this manner was secured the extortionate smelting contract with the Federal Mining & Smelting company complained of in a letter published elsewhere in this issue by Sydney Norman. In like manner, and for like purposes, and undoubtedly upon equally exhorbitant rates, were contracts secured by the Guggenheims for the treatment of the Ray and Chino mines, by purchase of large blocks of the shares of these companies.

Because of the exclusive experience of Manager Jackling in the development, and treatment, of these new-born ores, and of the eminence he had attained as an engineer, it was an easy task to rejuvenate the old Ray Con. and Chino mines, and to secure from the public all needed financial help without impairing, or imperiling the majority holdings of the promoters. All that was necessary then was the co-operation of Manager Jackling, by his selection as vice-president and general manager of these properties

In order to create a proper appetite for these securities Manager Jackling was delegated to distribute a number of shares in these properties among influential followers, including reporters, and attaches of various newspapers, and in other channels of publicity. These distributions, however, did not involve the actual delivery of the shares, because that might disturb market manipulation, but simply a brief note stating that the holder was entitled to a certain number of shares at a stated price—which, in the case of Chino, was $5—the shares to be sold or taken over by Manager Jackling on the order of the recipient, and the difference between the price stated and the market value to be paid over to the holder of the option. No payment of any sum was required for the privilege of the option, the idea being that it was the desire of the manager to confer a personal favor upon the party, and that the stock was being carried without cost to him—Jackling.

The popularity which these issues and the parent Utah Copper attained in the manner stated is well known to every one who has followed the mining share

market. Hayden, Stone & Company, and other brokers, discerning the market value of Manager Jackling's reputation as a great engineer, thus built up, having first secured large holdings in the Utah Copper, joined the Colorado contingent in the flotation of Ray and Chino, Hayden, Stone & Co. becoming official underwriters for all bond and stock issues put out by those companies, the large clientele of that company at once assuring the absorption of any issue bearing their endorsement. And in this manner many millions of dollars have been secured from the general public by which means all the needed finances for any scheme, no matter how spectacular or chimerical, were readily obtained.

Notwithstanding the magnitude—on paper—of these three big enterprises, the ambition and greed of these promoters was not satisfied and so Butte & Superior was hooked up, and the public mulcted of several millions of dollars, no mean portion of which was contributed by local followers, many of whom had been beneficiaries of the profits arising from the gratuitous distribution of Ray and Chino shares, as before stated, and a considerable number of the sufferers from the Butte & Superior deal, it is said, were present at the "farewell banquet" given Manager Jackling early in the present month. The inside history of the Butte & Superior deal has already been given in a former issue of this journal.

Following this, these grasping promoters, with their precious mascotte—who in this case was supplemented by A. F. Holden—proceeded farther north and undertook, under the name of the Alaska Gold Mines Company, the rehabilitation and market promotion of the old and worthless property previously known as the Perserverance, and situated on the mainland of Alaska, about six miles from the famous Alaska-Treadwell gold mines, upon the successful operation of which it was hoped to float the shares of the Alaska Gold Mines Company, solely because of its proximity to this great mine. But the fact becoming exposed that the property of the Alaska Gold Mines contained no ores of any possible commercial value, of course an absolute collapse, so far as distribution of the shares is concerned, followed. True, the "noise" is still being faintly kept up, and considerable work is being done upon a great tunnel, but every prediction of the promoters has been discredited and this unsuccessful attempt to fleece the public forbodes an early and absolute failure of the scheme. The chief trouble in this case exists in the fact that the scheme was born about two years too late, and after the early demise of the master scheme had become a certainty.

SMELTER SMOKE COMMENT

In spite of the fact that "big business" does not dare to say a word or to lift a finger against the smelters, no matter how much of a public nuisance they may have been proven to be, there nevertheless are scores of prominent people in the city and the county who have expressed their hearty approval, and have strongly commended Mines and Methods' smoke fight.

A prominent mining engineer and operator writes: "I have read with much interest the articles on smoke in Salt Lake City. I distinctly remember some years ago when the dust from the unmuzzled smelter stacks was reported by prominent professors and officials to be 'volcanic dust,' but I had some of it examined by an assayer, who told me the volcano that emitted that dust was within the valley. * * * Don't use my name in connection with this, publicly. I am in the employ of the Blank Blank Mining Co., and you can see they would not like me to butt in."

A leading citizen of Salt Lake says: "You have made the most significant revelation and the most important discovery ever made effecting the history of any city. Your smoke stories will mark an epoch in the growth of Salt Lake City. It may not come now, but it will come ultimately, and it will be principally because of your tracing the smoker to his home."

The owner of a large non-smoking furnace in this city says: "You have astonished this whole community; that the smelters are largely to blame for our city smoke is a terrible charge to make; terrible because we must have the smelters and their business, and yet it does seem that you are right in the matter. I am indeed sorry to be forced into this belief. However, the city was here first and I hope vigorous and effective action may be taken soon that will bring the least harm to the smelters and the greatest good to the city.

A Salt Lake City manufacturer comments as follows: "That is a pretty serious charge you have made against the smelters, but your bravery in speaking out in this matter is very refreshing. There has never been so plain a case of circumstantial evidence against any one anywhere as you have made against the smoke makers. I am a serious sufferer in both health and property loss from this exasperating smoke nuisance, and I will contribute one hundred dollars toward any campaign that will remove the smelters from the valley. However, I cannot wish them to suffer the loss of a single nickle, and as a property owner in this city I am willing that the city should bond itself as much as three million dollars to pay for the removal and rebuilding of the smelters a safe distance from here."

SUMMER "SALT" STORMS

The so called "salt" storms that are common in Salt Lake City in the summer time when thunder showers occurring after a long dry spell wash down the dust from the atmosphere and spatter it over our windows and clothing in a very nasty manner, really contain no more salt than they do pepper; the salt flavor tasted is from the perspiration of the finger or hand of the taster.

The dust is almost exclusively desert dust so far as it is derived from points outside the Salt Lake valley, which the summer winds keep blown about from place to place, though it has just been ascertained from an examination of the gray dirt deposited last summer on the Boston building roof during a thunder shower from the southwest and carefully gathered at that time, that it contained smelter smoke particles in good quantities. As a matter of fact, a competent assayer made a careful fusion test of a quantity of this dust and found sulphur in appreciable quantities, a summary of the analysis revealing the amount to be at least one and one-half per cent of the total bulk of the dust gathered from the copper roofing after the shower.

Since the fires of Salt Lake City were not burning (in August), and since the storm came from the southwest across the Salt Lake valley, we are forced to the conclusion that the sulphur was not from the coal burned in Salt Lake City, nor from the spray (?) from Great Salt Lake, but that it came from the sulphur spouted into our summer sky by the smelters.

The amount, 1½ per cent, is however, but a very small amount of the sulphur combinations indicated to be in the air by this test, because during the storm, the surcharge of the sulphurs in the air, is transformed into sulphuric acid and other solution forms of sulphurs, by the rain drops, and this is not deposited as a dust or powder that can be gathered up as was the sample under consideration. From this observation it will be seen that the haziness of summer, which is washed down in great "gobs" by summer showers, is caused very largely in the Salt Lake valley by a prolific sulphur maker—or to be exact, THREE good, hardworking sulphur makers.

Extracting Gold From Gravel Deposits (VI.)

By AL. H. MARTIN.

Intelligent prospecting blazes the way for profitable mining. Unless the extent and value of a gravel deposit is known beyond all conjecture, the success of the enterprise is shrouded in doubt. As in quartz mining, it has too often been the practice to outline operations and install costly equipment before a fitting knowledege of the property has been acquired. In other cases inexperienced men have supervised the perfunctory examination and testing of properties, and lessons that would have been valuable guide posts to the qualified engineer were as blind walls to the untried men in charge of the work. There are so many prime essentials entering into the examination of a placer property, that the matter is worthy of a greater consideration than has been generally extended it. Not only is the prospecting of the ground calculated to determine its merit for being operated, but also should indicate the best methods to be utilized in extraction of the gold.

If the deposit is best worked by a dredge, or an elevator, or a steam shovel, the data so indicating should be gathered in the testing of the material. Ground too difficult or shallow to warrant the installation of a bucket-elevator dredge might be an ideal project for the dragline excavator or hydraulic monitor. And another deposit that was too deep for more restricted methods, might develop into a profit yielder if mined with dredges. The machine best adapted for any particular work is the one that gives maximum results at a minimum cost, without sacrifice of efficiency. Limited ground, climatic conditions, local laws and regulations affecting operations, financial status of the operating company—all these and many more factors demand consideration aside from the mere value and character of the deposit under consideration.

CAUSES OF FAILURE.

The vast majority of placer mining failures are directly traceable to an imperfect understanding of the conditions prevalent at the outset. And it can be safely asserted that fully two-thirds of the failures were due to careless prospecting. Even when the utmost care is exercised in testing ground, the greatest discretion must be exercised to guard against erroneous samplings. So well is this danger comprehended by expert mining engineers that in examination of California dredgable ground, and computation of average values throughout the deposit from the samples secured, it is customary to figure the gold content recoverable at 75 to 80 per cent less than the value indicated by samples from drill holes and prospect pits. There are so many chances for errors in collecting samples, and in their subsequent handling, that the reduction of indicated values about one-fourth is considered the one safe course. And actual operations have demonstrated the practice to be justified as there is always a certain amount of fine gold lost in handling the gravel, in addition to the varying values between indicated asd recoverable gold content.

While their cost oftentimes militates against their employment, prospect shafts are unquestionably the safest and most certain guides to the actual merit of a placer. This is particularly so when the work is in the hands of men who have not had long experience in sampling gravel. Presence of quicksand or very loose ground, requiring extensive timbering, often precludes the sinking of these shafts because of prohibitive cost, but under fairly favorable conditions their use is strongly recommended by most engineers. The shaft enables the examiner to gain a more comprehensive knowledge of the character of the ground and formation, facilitates the taking of a large sample, and largely reduces the possibility of errors in computing value of the estate if care is exercised in collecting the material.

It is the usual practice to sink round shafts with a uniform diameter of thirty-six to forty inches from top to bottom. If the deposit is deep, ranging below thirty feet the larger diameter is employed, but for comparatively shallow deposits the shaft with a three-foot diameter is usually found of ample size. With conditions favorable such shafts are sent down at a cost of 50 cents to $2 per foot, the expense varying with character of ground, labor costs size of hole, etc. While a fairly large shaft costs more than a smaller one, its use is recommended in testing fairly deep deposits, as it is false economy to cramp the workers, or handicap the engineer in his selection of samples. When the ground is wet and requires extensive timbering, the prospect shaft often ceases to be advisable, as the water not only runs up the cost and handicaps work, but so disseminates the gold values that it is generally necessary to check results with a nearby drill hole. Some operators use iron caissons when prospecting wet ground. In dry ground it is the usual practice to take only a small section of the shaft from top to bottom for testing, but in wet ground, or when the caissons are used the entire content of the pit is taken.

The location of shafts and distance from each other largely depends on the character of the ground. Hence a careful preliminary study of the deposit often results in marked saving of time and reduction of drilling costs. In making the early examination, the engineer usually sinks a few holes at widely divergent points to establish extent of commercial ground, and to learn if the gold occurs in channels or is fairly evenly distributed. If values are found fairly well disseminated and uniform, less testing is required, but if the gold occurs in bunches, or in narrow channels, careful work is necessary to conclusively demonstrate the actual merit of the deposit. After the first shafts have been completed, the engineer generally has sufficient data to outline the character of the subsequent work. The ground is then divided into sections and each division tested.

CORE DRILL PROSPECTING.

The correspondingly lower costs of prospecting with core drills under any and all conditions, and the rapidity with which work is preformed, has made this form of prospecting particularly popular with placer operators throughout the world. The drill works alike in wet or dry ground, and often under conditions where the shaft method would be beyond the range of economic consideration. Consequently the drill has largely displaced the prospect shaft in many districts, notwithstanding the admitted superiority of the latter means in many instances. A careless runner may render sampling of a deposit worthless and misleading by negligent driving of the casing. If the pipe is kept too far ahead of the drill bit the subsequent pumpings often fails to produce sufficient material to give a true index to the gold content of the deposit, while if the drill precedes the pipe an excessive quantity of material is drawn out by the pump. In either instance the samples are worthless inasmuch as they relate to actual value of the gravel. Such errors in drill running have been numerous when inexperienced or careless runners were in charge of machines, and it is largely because of such chances for error that many engineers prefer the prospect shaft. Another fruitful cause of inaccu-

rate samples is the tendency of some drillers to eliminate the casing when prospecting hard ground. The practice is considered as almost certain to give misleading results and is strongly condemned by most engineers, as there is always the danger of loose material below the driving shoe adding its gold content to the actual core drawn out by the pump. This naturally results in indication of a gold content far above that actually existing.

It is imperative that each foot of the casing pipe be marked, also the drill rope, in order that an accurate record of the changing depths of the hole, and efficiency of the drill be kept. The bit must be kept sharp and in best of condition, as a dull cutting edge may result in flouring of gold if used for any length of time. The type of drilling bit is determined by the character of ground, as a hard bedrock, or boulders require a heavier and wider angled cutting bit than loose gravel. A thin-bladed bit is desirable in drilling gravel as a heavy one would pack the material instead of cutting cleanly, and probably force some of it to the side of the pipe below the cutting shoe.

The type of drill used depends largely on its demonstrated efficiency, and the choice of the operator. In California placer prospecting the favorite machine is the Keystone No. 3, of the traction type. It is self-contained, and equipped with either an 8 or 10-horsepower boiler, or electric motor. Electricity is preferred for motive power whenever it can be cheaply obtained, but with the boiler attachment, wood, coal or oil can be used for generation of steam. The casing pipe is generally cut into 5 to 7-foot sections, with inside diameter of six inches. Practice has shown the best results are obtained with a long quick stroke and the drill is usually adjusted to deliver about 55 strokes per minute, with the stroke about 38 inches long. This prevents settlement and recutting of material between strokes, with a possible loss of fine gold. The casing must be constantly kept perpendicular, otherwise a bent pipe may force abandonment of the hole before the bedrock is attained.

The handling of the drill should never be intrusted to an inexperienced or careless runner when gold-bearing gravel is being prospected, otherwise inaccurate samplings and mechanical troubles are practically certain to develop. After the drill is raised from the hole, the loose material in the casing is drawn out by the sand pump; a vacuum machine composed of a hollow steel cylinder provided with a valve on a piston traveling the entire length of the cylinder. The vacuum produced by the action of the valve and piston sucks out the water, sludge and small rocks, which are held in the pump by the foot valve in the shoe. If the ground does not contain enough water, sufficient is kept in the casing to facilitate both drilling and pumpisg.

WHEN CARE IS IMPERATIVE.

As the gold content of most placer deposits is concentrated near the bedrock, particular care must be exercised in completing the final section of the drill-hole, otherwise the care taken in computing value of the upper ground will be of little value. It is on the pay-streak that the value of the enterprise depends, and on the accurate sampling of this depends in a large measure the success or failure of the project. Occasionally a rich pocket of gold may be tapped, and when this occurs, as indicated by the sharp rise in values, it should be noted apart from the record kept of the balance of the hole in order that real average values be not disturbed by a false calculation of excess gold. The pumpings are discharged into small rockers, and the panning carried on in iron wash tubs.

The amalgamation of the gold is carried on under the temperature that would prevail on the dredge, if identical conditions can be provided. If the gold does not amalgamate the reason should be learned, as many placer installations have been failures because of this feature. It then devolves upon the examining engineer to determine whether the deposit is of sufficient extent, and gold values high enough to justify provision of additional equipment for recovery of the refractory values. And even it should be remembered that the deposit must clearly display its ability to return the original investment to stockholders, plus a satisfactory interest rate.

Unlike a quartz deposit, the surface gravel project cannot be figured to produce beyond its demonstrated extent. There is no possibility of future work increasing productive area or value of the material, the enterprise must stand or fall on the results gathered in the prospecting. It is for this reason that the eventual yield of a surface placer can be figured closely, and its necessarily limited life correctly estimated. The ordinary dredge or hydraulic mining project is largely withdrawn from the usual conditions affecting the mining industry, save in exceptional cases, for its period of productiveness, and ultimate yield are capable of mathematical calculation. With the extent, character and value of the deposit conclusively established and comprehended, the intelligent engineer is in a position to recommend the best type of gold-extracting equipment for the particular requirement.

PURPOSE OF PREVIOUS ARTICLES.

In preceding articles the writer has endeavored to point out the merits and demerits of the various mechanical devices for recovery of gold from gravel channels, and the natural conditions that demand consideration before the particular installation is resolved on. Epitomizing, it can be said that the best machine for any particular purpose is the one that best accomplishes its purpose with a minimum expense and maximum efficiency. The experience of the supervising manager is an important element in the successful conduct of any enterprise, and particularly so when gravel mining is concerned. Careless prospecting of the deposit, or ill-advised selection of equipment not infrequently leads to failure, whereas careful work and and consideration in the beginning would have spelled final success. Any man can make a bonanza pay, but it takes a good man to coax profits from a poor mine. The desire to do does not always imply the ability to accomplish. Most men imagine they could manage a mine, but the tried engineer proceeds only when he is absolutely certain.

An immense amount of gravel mining is carried on without aid of mechanical appliances, but the methods are so simple and well-understood that they can be comprehended without special effort. Ground-sluicing is one of the oldest forms of placer mining extant. Man early learned to bring a stream of water from a friendly creek or rivulet to wash away a bank of gravel, and yield unto his keeping the coveted golden grains. This method is still largely employed whenever it can be utilized effectively, but requires considerable water and highly favorable topographical conditions to achieve best results. Oftentimes however it lends itself admirably to the plans of the small operator, particularly when a good tailings ground is convenient, and there are no unfriendly laws to prevent the worker from sluicing the debris to any point he desires. A good water supply, a few ditches or flumes, and sluices to capture the gold as the material is washed down, constitute the required equipment in most cases.

DRIFT MINING POPULAR.

Drift-mining is largely employed in working deep gravel deposits, and many of the best gravel producers in the world are mined by this method. Work is conducted much as in the mining of quartz. Shafts are sunk and drifts and crosscuts extended, or the work is conducted through adits and attendant workings. Generally it may be said that the ideal way of working a drift gravel mine is by means of adits and drifts and raises

Surface prospecting determines the value and possible character of the deposit, so far as it has been opened, but extensive development work is essential to really indicate the merit of a drift mine. The work partakes of the characteristics of quartz mining, and it is impossible to guage the life of the enterprise or estimate its intrinsic value. The future is freighted with possibilities. This is particularly true of a new district, where the operator has little or nothing to guide him in his work. In older fields where neighboring companies have extensively operated, a fair idea of a new property's value may be gained by using advantageously the experience of the earlier workers.

Mining a gravel mine with shafts means the employment of hoisting, and frequently pumping, machinery. This naturally means that power costs, expense of purchasing and maintaining equipment, and higher labor costs must be figured on. When the deposit is worked through an adit, the hoisting and pumping expenses are eliminated. Transportation of the material through a long tunnel involves expense, but not to the extent that would attend identical work through shafts. Considerable timbering is generally required to sustain the walls and roofs of adits and drifts, also to prevent running of ground. It not infrequently happens that much of the gravel is of cemented character, necessitating the building of a gravel mill for crushing of the material and release of the gold. By the drift mining method, deposits are worked to considerable depth, and the practice is often the only one that can be advantageously employed. And there is a lure, a wonderfully enticing summon, in drift mining that no other form of gravel operation approaches. There is ever the chance of striking a rich pocket, ever the hope of transforming the mediocre prospect into a phenomenal producer. The channel may be barren of values today, but tomorrow, ah! tomorrow may see the gravel glittering with its golden freight; tomorrow may mean the laying of wealth in the lap of the prospector who has so long and fruitlessly dreamed of Fortune's smile. It is this song of the Sirens, this what may be, that makes the drift gravel mine so attractive to the prospector, the miner, the speculator. And it is this same spirit of adventure that has done so much to place mining in the forefront of the world's industries.

The gravel deposits were the first to yield gold to primitive man. The gravels of California started the greatest gold rush in the history of the universe and builded an empire in the great west. It was the rich surface gravels that focused the attention of the world on Australia, and then forced Alaska and the Yukon to the centre of the stage. And the development of another virgin gold field, if there still remains somewhere on earth another California or Klondike, will most certainly be heralded to the world by the auriferous treasures of the surface sands.

Liquidated Value of Mining Stocks

To the investing public generally there is no subject worthy more diligent study than that covering the valuation of mining stocks. Financially astute in matters pertaining to investments in railroad and other industrial securities, investors are prone to regard mining enterprises in the same light. In that respect they err. Primarily, the conditions surrounding a self-contained railroad or manufacturing enterprise are conducive to a progressive increase in assets from year to year in addition to a decided permanency of dividend-earning capacity. This is not true of mining enterprises, as reflected in the fact that each successive year's operations depletes the assets thereof. In short, the former is permanent, the latter transitory.

The liquidated value of any enterprise is one of the most important factors in determining the prices of stocks. Strangely, however, the investing public seems to not consider this factor in relation to mining investments. This feature is reflected in comparative market quotations of railway, industrial, and mining stocks Regardless of the ultimate value of the respective stocks it will be seen, from a perusal of market quotations, that the general list of mining stocks command prices greatly superior to many industrial enterprises, even under the circumstances wherein the assets, earning capacity, permanency of operation and dividend payments, together with other attendant factors, are largely in favor of the latter. This condition of affairs suggests the absolute necessity for more conservative reasoning in connection with mining investment securities.

The following article by Mr. Arthur O. Christensen and appearing in the January 1913 Mexican Mining Journal will doubtless be of interest to readers as it outlines many of the governing factors relative to mining stock valuation. We are presenting only the most salient features of the original article, together with an abbreviated list of large mining properties, the latter outlining the factors governing the liquidated value of the respective stocks, based upon the figures given by the management of the respective properties covering the physical and financial operating costs, etc. In reference to the foregoing we beg to call attention to the fact that the figures contained in the table mentioned, are subject to decided revision, particularly as regards percentage recovery of marketable minerals, costs of production per pound refined metal, grade of ore developed and treated, and ultimate ore tonnage recovery. The statement of condition of the Miami property is correct in but one item—cost of production—which should be 9.69 cents in place of 7 cents. Of the remaining companies operating costs, etc, all are incorrect, as the average production cost of copper ranges from 10 cents to 14.83 cents per pound. However, the object of this article is the presentation of fundamental principles underlying mining investments, and the table here used is merely illustrative of those conditions rather than as a presentation of the actual facts therein, which obviously could not obtain when it is considered that the figures given were prepared by the respective companies' management:

In view of the lack of anything like a clear or general understanding of the intrinsic values of those mining stocks which we see quoted in the daily papers the following discussion may be worth while, even though it attempts what perhaps appears the impossible; arriving at the intrinsic liquidating values of the shares of several representative mining stocks, with a discussion of the data and steps necessary in arriving at these values.

The calculations herewith made are based on seven fundamental items. The degree of accuracy with which this data can be estimated is dependent on the degree to which the mine in question is developed. Every mine has a demonstrated and a speculative value. The latter cannot be estimated with any degree of certainty so in a discussion of this sort only the more developed mines are considered, although even in most of these cases some allowance is made for probable, as well as developed ore. These seven basic items are as follows: (1) Annual production, (2) Recovery of metal per ton, (3) Cost of production, (4) Ultimate tonnage of ore in the mine, (5) Revenue not included in ore production, (6) Cash and other quick assets in ex-

cess of liabilities (not including convertible bonds which will probably be exchanged for stock). (7) Shares of stock issued (including those shares held for conversion purposes which are worth apparently the equivalent of the stocks or bonds for which they are likely to be exchanged.)

The estimate of ultimate ore to be extracted from the mine is the most difficult one to make and has usually been the sine qua non of most attempts at mine appraisal. In the case of the "porphyry coppers" the minimum of this item is definitely known.

Where ore reserves are large in proportion to rate of production or there seems a considerable speculative value in the property the stock may rightly earn a lower percentage.

If a mine is capable of maintaining its present rate of earnings for 21 years, at the end of which time it be entirely exhausted, its earning should be 10% of its present price (its price should be [illegible] of its earnings) in order to refund the principal at the end of this time and pay 7% interest on the investment, as will be discussed below. Such an age for this class of mines seems a fair estimate. Of course a mine usually does not maintain its maximum output and average grade of ore to the end. We do not expect that the mines taken up in the accompanying table will cease operating at the expiration of the periods estimated for their respective lives, but it is probable that the value of these mines would be about the same whether they maintain their earning capacity for the period given and then cease entirely, or die a gradual death, as is more likely to be the case. For the purpose of this paper it is simply following accepted practice (which we feel is justifiable) to estimate the life of the better developed copper mines as about twenty-one years, adding to or subtracting from this estimate as the comparative conditions of the properties seems to require.

Each person must judge for himself whether the estimated life of the mine, and in fact the other six fundamental items, are too favorable or too severe for the particular mine in question; whether the mine has its estimated ore tonnage largely developed or simply has a promising prospect of ultimately obtaining that much. In other words he must judge whether the risk of the mine not coming up to the given estimates is greater or less than the chance of its doing better.

On first consideration this method of estimating the life of a mine may seem so crude as to defeat the whole purpose of the article. Suppose the mine to have an effective life of 32 years instead of 21 (approximately 50% larger), what will be the difference in the present value of the stock? Turning to Fig. 2 we see that (allowing a 7% return on the investment) the one running 21 years must yield 10.1% in order to return principal at the end of this time. Each dollar annual revenue therefore has a liquidating value of $\frac{100}{10.1}$ =$9.90. Where the investment runs for 32 years the Fig. shows the required rate of earnings to be 8.6% of the value of the investment, which is then $\frac{100}{8.6}$ =$11.62 or 17.4% greater than in the former case. Thus the mine with more than 50% longer life is worth only 17.4% (or about a sixth) more.

To take an actual case: Ray Con. is estimated to have a life of 23 years. Its earnings should therefore be 9.7% in order to yield 7% on the investment and amortize the principal at the end of 23 years. Utah Copper has an estimated life of 40 years (77 per cent longer) Fig. 2 shows that 8% is required in this case. For each dollar of annual earnings Ray Con. is worth $\frac{100}{9.7}$ =$10.30 and Utah Copper $\frac{100}{8}$ =$12.50, or 21.3% more although its life be 74% more. There is thus an economic limit to developing ore reserves, even for a porphyry mine. Fig. 1 shows that, assuming money worth 7% if Utah Copper were to add another year's supply to its reserves the present value of the profits to be derived therefrom is less than 7% what the profits will be 41 years hence. Whether we estimate the life of a mine at 20 or 25 years makes a difference of only about 10% in the capitalized value of its earnings.

The remaining three items on which calculations are based are obtainable from reports issued by the companies.

The accompanying table gives an illustrative list and works out the intrinsic value of the stock in each case. The figures given are those expected to hold for the whole estimated life of the mine, should present plans and conditions be continued. Increased ore reserves or additional treatment facilities would change the fundamental data so as to necessitate corresponding alterations in the calculations. This will probably soon be the case with such mines as Braden, but at present is only a speculative value. As conditions at the mines are altered the problem becomes altered and the value of the stock should correspondingly fluctuate.

Having assumed the life of the mine, its earnings may be capitalized in several ways. The simplest is to consider all earnings payable in a lump at the expiration of half the mine's life, this being the average time to which payments are deferred. Assuming payments to be made in equal installments over a period of 18 years, for example, the whole may be considered paid at the expiration of 9 years. Fig. 1 shows that, with money worth 7% the present value of such a sum is worth 54½% of its total or 18.545 =9.8 times the annual payment.

H. C. Hoover introduced the practice of capitalizing a mine's earnings by first deducting from each year's earning an amount such that if reinvested at 5% will, at the end of the estimated life of the mine, be equal to the original investment. The remaining income is considered a legitimate interest (7% for example) on the value of the property.

$$I = \frac{\left((1+i)^{n-\frac{1}{2}}-1\right)(E-r)}{\log_e(1+i)}$$

where I= per cent increase desired, i= the amount annually paid as interest per dollar. E-r=per cent reinvested for amortization, n=number of years required for desired increase of capital. Modifying this for our special case where I=100, and i=.04, the equation reduces to:

$$n = \frac{1}{2} + \frac{\log\left(\frac{3.921}{E-R} + .981\right)}{.0170}$$

where n=number of years the mine is to last, E= per cent earnings r=per cent annually paid on investment (herein taken as 7%).

Fig. 2 gives a series of curves showing this under varying conditions. From this

MINES	Shares ... (including those to be issued for bond ...)	Annual Production (Thousand tons)	Per cent Copper (...)	Per cent R[ecovery]	Rec[overy] ...	Annual Product[ion] (M[illion] ...)	Cost per lb.	Cost per Pound Copper ...	Value of Other Metal ...	Annual Profit from Metal Production (14½c) per ...	Ultimate ...	Estimated Life of Mine (Years)	Other Revenue (Annual)	Cash ...	Same per Share	Profit per Year per Share	Rate of Earnings Necessary to ... and Pay ...	Allowance of Deferred Operation	Earnings Capitalized ...	Total Liquidated Value
Braden	2,600,000	1,000	2.60	[illegible]	[illegible]	[illegible]	2.32	[illegible]	(1)	2,660,000	22	22		900,000	.35	1.02	9 9	.97	10.00	10.35
Chino	870,000	[illegible]	2.10	70	29.4	[illegible]	2 20	7½	(1)	[illegible]	51	30		200,000	.23	4.30	[illegible]	.98	37.90	38.15
Miami	748,325	1,050	2 25	72	32.4	[illegible]	2 27	[illegible]	.17	[illegible]	21	20		100,000	.80	3.48	10 4	.99	33.00	33.80
Nev. Consolidated	1,998,762	[illegible]	1.64	[illegible]	22.6	65	2.08	9,2	.7	3,900,000	43	15	1,300,000	3,000,000	1 50	2.60	12		21.65	23.15
Ray Consolidated	1,587,500	3,330	2.00	[illegible]	27 2	90	2 25	[illegible]	.006	5 616,000	77	23		1,000,000	.63	3.54	9 7	.97	35.40	36 00
Utah Copper	1,612,649	6,760	1.50	[illegible]	20 7	140	[illegible]	[illegible]	1 0	9,100,000	270	40	[illegible]	24,000,000	14 90	5 77	8	.99	71.30	83 20

it is seen that to pay 7% on the investment and return the principal in 18 years a yield of 10.9% is required. The value of the investment is therefore $\frac{1}{10.9\%}$ =9.17 times its annual earnings, which compares with 9.8 as found above by using Fig. 1: this discrepancy representing the difference whether the amortization fund is invested at 7 or at 4%.

The average price of copper is taken as 12½ cents a pound. This has been approximately the price in the past, and there seems no more reason for a lower than a higher price during the next twenty years.

Where the caving system is used, as is the case with Ray Con., Miami and others, it must be remembered that some 15% of the ore will be lost, and the grade of that which is mined will be lowered by admixture of waste. Even where ore is stripped and "steam shoveled" some waste is necessarily mined and a portion of the ore is lost. Thus both the tonnage and grade of the porphyry ore bodies should be modified to represent the ore which will be mined.

The value of stock of subsidiary companies which are independent of the controlling company is given in the column "Cash and Other Assets Independent of Mine."

While the data given in the accompanying table are only approximations, we believe they are as nearly correct as can be estimated from information obtainable. It is probable that time will show these estimates to be nearer the true values of the stocks than is represented by market quotations. If traders in the Stock market were in the habit of giving as much consideration to what they buy as is given to each stock considered above there would be fewer losses sustained, and the market would not have such an undesirable reputation.

A new alloy, containing a large proportion of iron, has been patented by John F. Duke, of Manchester, England, in United States patent 1,044,761 of 1912. The proportions are: iron, 50.30 per cent; nickel, 19.16; copper, 29.14, and aluminum, 1.40 per cent. It is white, non-corrosive, and resists the action of vegetable acids and the atmosphere well. If more hardness is desired add from 1 to 2 per cent of tin.

Nitrogen amounting to 810,000,000 tons has been wasted in the United States since 1893 through the use of the old-fashioned beehive coking oven. By-product coke ovens would have yielded from this coal 9,315,000 tons of ammonium sulphate, worth $60 per ton, which could have been used as a fertilizer.

Ultimate Source of the Metals

By BLAMEY STEVENS.*

It is now generally agreed that most metals have been brought to the surface of the earth by volcanic agencies. The question as to how these metals came from the volcanic matrix to the mineral deposit has been often discussed.

It might be useful to give more serious consideration to the ultimate origin of the volcanic material. It is possible that some light might thus be shed on the persistent associations of some metals with certain particular kinds of rocks. For example, the very general association of gold with acid types of igneous rocks, of tin with granites or quartz-felsites, of certain types of deep-seated copper-deposits with magnesian eruptives, and so on.

One interesting question is as to whether the metals brought near the surface by volcanic agencies appear here for the first time, or whether they came from the central core of the earth. The interior of the earth is, without doubt, much more highly metallic than the crust, and so the core is often thought to be the origin of many of the metals which are uncovered by man.

THE DIFFERENTIATION THEORY.

Although a great many theories bearing upon these matters have been discussed,[1] the only one now considered as worthy of much consideration among American geologists is the 'Theory of Differentiation of Igneous Magmas."[2] According to this theory, lakes of molten magma are supposed to exist very far down beneath the earth's surface. In these lakes a process of differentiation is supposed to be going on whereby the liquid magma is split up into two or more liquid phases. Each of these phases is supposed to take with it the metallic constituents for which it has the greatest affinity.

This theory is an endeavor, in the most simple way, to account for the emission of a varying and widely-different series of igneous rocks from nearly, if not quite, the same vent. The older idea of separate reservoirs was no longer feasible when there appeared to be so many necessary—for instance—seven at Tonopah and nearly twice as many at Goldfield. And thus the idea of the gradual splitting up of one magma was reached.

Like the old simple theory of the sun and stars moving around the earth, the differentiation theory cannot be definitely disproved, but it involves such a reversal of physical conditions, as we know them, from our experience on the earth's surface, that the probability of truth of the theory is reduced to a very small fraction.

The physical conditions which, according to the differentiation theory, are necessary, are that a liquid silicate magma shall split up into two or more liquid silicate magmas. On the surface of the earth we know of no case where this is so. If pressure and temperature could be considered to alter these conditions for silicates in general, it is very unlikely that some extreme type of silicate would not exhibit the same phenomenon on the surface of the earth.

Moreover, the same generalization applies to other than liquid silicates; for example, liquid sulphides, liquid arsenides, and also, where we have had a lot of experience, with solutions in water.

It is true that variations of physical conditions, such as heat, gravity, or electric state, in different parts of a solution, may produce corresponding variations in its composition. These effects must, however, be so small as to be negligible in magma reservoirs. If such reservoirs were of large dimensions, convection-currents, due to loss or gain of heat, would entirely nullify any such differentiation effect.

Fractional crystallization is not seriously advanced as a general explanation of the emission of lavas of varying composition from the same vent, and

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* Mining Engineer, Temascaltepec, Mexico. Trans. Am. In. of Mining Engineers, March, 1913.

[1] Dutton, Hawaiian Volcanoes, Fourth Annual Report, U. S. Geological Survey, pp. [illegible] to 170 (1882-83).

[2] Iddings, Igneous Rocks, chap. vii. (1909).

Zeitschrift fur praktisch. Geologie, vol i., pp. 4 to 11, 125 to 143, 257 to 284 (Jan., Apr., July, 1893).

[3] Philosophical Transactions of the Royal Society of London, vol. clxiii., pp. 147-227 (1873).

Trans., xl., 175 (1910).

[4] The Crystalline Structure of Metals, Philosophical Transactions of the Royal Society of London, A, vol. cxcv., pp. 279 to 361 (1900).

[5] Thomson and Tait, Treatise on Natural Philosophy, p. 423 (1883).

[6] Rankine's Applied Mechanics, 4th edition, p. 304 (1868).

[7] Trans., xl., 175 (1909).

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[11] Trans., xli., 650 (1910).

[12] Iddings, Igneous Rocks, p. 257 (1909).

[13] Barus, American Journal of Science, 4th Series, vol. ix., No. 51, p. 173 (Mar., 1900).

[14] Bulletin No. 109, U. S. Geological Survey, pp. 27 to 32 (1893). See also A Treatise on Metamorphism, Monograph XLVII., U. S. Geological Survey (1904).

[15] Trans., xli., 650 (1910).

[16] Geikie, Text-Book of Geology, 3d edition, p. 231 (1893).

[17] Idem, p. 244.

[18] Idem, p. 255.

there is no reason for discussing this process at length. To illustrate what is meant by fractional crystallization, we might imagine a garnet to be melted up and then slowly cooled. It would not again crystallize out as a garnet, but as two or more silicates, or as silicates and a residual magma, or glass. As the silicates are formed, the residual magma changes in composition, and with a fractional crystallization theory would be considered to be extruded at periods during such a history. Fractional crystallizations of aqueous liquids carrying silica and other materials have been formed in the end-stages of solidification on comparatively large scales, but these aqueous crystallization phenomena cannot be advanced as any general explanation of the varying composition of successive volcanic outpourings. A proof of the general mixing effect which obtains in magmas, except during the last phases of total solidication, lies in the fact that the large silicate crystals (phenocrysts) which are formed, remain more or less evenly distributed throughout the magma.

Fractional crystallization as a means of segregation has been given as an explanation of certain peripheral deposits of pyrrhotite and nickel-ore. Even this peripheral pyrrhotite-nickel type of deposit, which is described in great detail by Vogt,[3] may now be equally well explained on the more modern and more rational emanation theory; that is to say, they are more likely to be interstitial and replacement depositions made in the solidified periphery by emanations from the still-solidifying central portion of the intrusion.

Some titaniferous iron-ores have been cited as cases of either differentiation or fractional crystallization, and it is quite possible that this may be the case, but titaniferous iron-ore is not a silicate, and proof of its differentiation from silicates would be no proof of the possible differentiation of silicates.

MISCIBILITY OF LIQUIDS.

The tendency of liquids to mix is not due to affinity but rather to cohesion. Liquids possess the quality of cohesion in common with solids, and the property of continuous rearrangement of molecules in common with gases. Any liquid exhibits the property of cohesion among its own constituent molecules. When two liquids are placed together the cohesion may be greater among unlike molecules than among like molecules. In this case the liquids are miscible.

It is well known that in the smelting-furnace a liquid metallic lead-bullion differentiates itself from the liquid silicate slag; in other words, the liquids are immiscible.

No one has ever known, however, of a liquid silicate splitting into two liquid silicate constituents; in other words, liquid silicates are miscible in all proportions.

High temperatures tend towards miscibility; that is to say, away from differentiation. If liquids were apt to contract on differentiation, physical conditions might be so changed at great depth as to render the differentiation of silicates possible. As a matter of fact, when two liquids are mixed there is no known increase of volume large enough to be considered as even a small factor tending towards differentiation.

In 1875 R. Mallet[4] tried to show that igneous fusion is due to horizontal compressive crushing in the earth's crust. He calculated the energy necessary to crush rock into an impalpable powder, and showed that enough heat could thus be generated in the world to account for the fusion of all the lavas and igneous intrusions which are being made.

It was subsequently pointed out, however, that the heat so formed could not be concentrated locally so as to produce a sufficient elevation of temperature for the fusion of rocks.

I have shown[5] that the extension of moderately inclined fissures to considerable depths implies that much superior stresses are required to break rocks at great depths than near the surface. Consequently, a great deal more heat may be developed in the crushing of a deep-seated rock-mass than was formerly contemplated. Moreover, this crushing effect can be repeated over and over again on the same material, producing each time an additional amount of heat. The squeezing of a mass of sand might illustrate this to the average mind. Work is certainly done on the sand and turned into heat, but no particle of sand is necessarily broken or worn. By this crushing effect under great pressure, the cohesion of a rock-mass is not necessarily reduced. The rocks at great depth are not, in fact, crushed into powder, but forced to flow like plastic material. Pebbles in crushed conglomerates are often considerably flattened, and have even been known to be reduced to the thickness of a leaf.

This form of flowage may be brought about by the yielding of the material beyond the elastic limit, or by the agency of aqueous or other solutions in the pores of the rocks. Such solutions tend to dissolve material from the crystal-faces which happen to be nearly at right angles to the direction of greatest stress, and to deposit it on the faces which are more nearly at right angles to the direction or directions of least stress. In order to estimate the energy transformed to heat, it does not, however, matter how the distortion comes about if we can ascertain the amount of stress and distortion involved.

In order to define our ideas let us represent the mean vertical pressure by DH, where H is the depth at which the distortion is taking place and D the mean density of the overlying rock. Let the greatest horizontal pressure be DHI, where I will be the ratio between the greatest and the least stresses. The stress difference which caused the distortion is then DH--I-1.

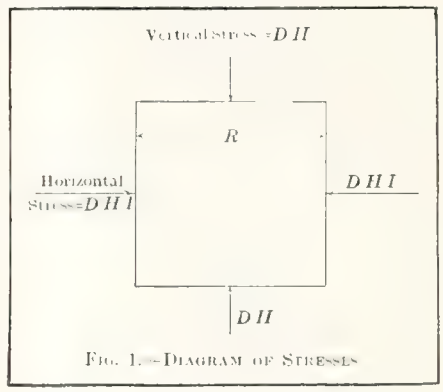

FIG. 1.—DIAGRAM OF STRESSES

Suppose this pressure difference to compress a unit cube of the rock, Fig. 1, so as to make its last breadth R, instead of unity. As the block must expand inversely as its thickness, the area on which the stress difference now acts is $\frac{1}{R}$.

The increment of energy turned into heat for a decrease —dR of the least dimension will then be $\frac{-DH(I-1)dR}{R}$ so that the total energy of distorting the original unit cube of rock is $-DH(I-1)\log_e R$

If J be the mechanical equivalent of heat, the amount of heat formed per unit weight of rock will be $\frac{-DH(I-1)\log_e R.}{J}$ From this formula I have prepared Table I, which is intended to appeal to the judgment of geologists on the general probability of truth of the theory.

Much of the distortion of rocks may be due to metasomasis or the re-formation of crystals but microscopic examination of nearly all distorted rocks shows that the crystals are permanently strained and therefore the yielding-stress is a criterion.

The phenomena of yield in metals has been studied by Prof. J. A. Ewing and W. Rosenhain,[6] who find that it consists of a number of minute shears which occur mostly along the cleavage or gliding-planes of the crystals.

So far as I know, the effect of other than simple stresses on yielding has never been experimentally studied. This is owing, no doubt, to the difficulty involved in simultaneously measuring stresses in more than one direction on an experimental specimen.

Darwin[7] assumed that the stress difference necessary to yielding was constant, but, as first pointed out by Hodgkinson,[8] this is contrary to the deduction

from crushing tests, where the rupture is usually a shear.

FRICTIONAL STABILITY.

In a former paper,[9] I showed that as soon as these yielding cracks or shearing-planes are formed, the rock-mass becomes subject to the laws of frictional stability of a granular mass, as deduced by Rankine; and in general the ratio of greatest to least stress becomes $I = \frac{1 + \sin(\text{ang. } X)}{1 - \sin(\text{ang. } X)}$, where X is the angle of repose of the granular material.

It will be noticed that I is determined only by the frictional angle or by the coefficient of friction. Friction is one of the most constant physical quantities we know of. The smallest quantity of solid matter we can weigh has about the same angle or coefficient of friction as the largest quantity we can weigh. We are therefore justified in assuming that some degree of constancy will be maintained up to pressures which destroy the solid properties of the material.

Determined experimentally,[10] X is the angle with the horizontal to which a plane may be tilted before any given object will slide down on it.

For conditions at comparatively small depth between freshly broken rock surfaces X is about 42°, and therefore for simple rock-pressures I = 5, approximately, or if the gravitational water-pressure is added and the greatest stress is assumed to be horizontal, I = 3.5. According to the evidence afforded by intrusion[11] of magmas, I is always reduced where there is evidence of plastic flow. It is impossible to say what the exact value may be, but it seems reasonable to put it at about 2.0.

TABLE I.—British Thermal Units Evolved by Various Stress Differences and Deformations. $H \cdot (I-1) \cdot \log_e R$

Stress Difference in Feet of Rock Head = H (I-1.)	Deformation Ratios = R.						
	1	$\frac{1}{2}$	$\frac{1}{5}$	$\frac{1}{10}$	$\frac{1}{20}$	$\frac{1}{100}$	$\frac{1}{1,000}$
1,000	1	3	5	7	10	14	21
2,000	2	7	11	14	20	28	42
5,000	7	17	28	35	49	69	104
10,000	14	35	56	69	98	138	208
20,000	28	69	111	139	196	277	415
50,000	69	173	277	346	490	692	1,038
100,000	139	346	554	693	980	1,386	2,077
200,000	277	693	1,108	1,386	1,960	2,772	4,155
500,000	693	1,732	2,771	3,465	4,901	6,931	10,388

TABLE II.—Values of Stress Differences (I—1) H for Various Values of H and I.

Vertical Depth or Head H Feet.	Stress Ratio, I (for Simple Rock-Pressures).						
	1.1.	1.2.	1.5.	2.0.	2.5.	3.0.	5.0.
1,000	100	200	500	1,000	1,500	2,000	4,000
2,000	200	400	1,000	2,000	3,000	4,000	8,000
5,000	500	1,000	2,500	5,000	7,500	10,000	20,000
10,000	1,000	2,000	5,000	10,000	15,000	20,000	40,000
20,000	2,000	4,000	10,000	20,000	30,000	40,000	80,000
50,000	5,000	10,000	25,000	50,000	75,000	100,000	200,000
100,000	10,000	20,000	50,000	100,000	150,000	200,000	400,000
200,000	20,000	40,000	100,000	200,000	300,000	400,000	800,000
500,000	50,000	100,000	250,000	500,000	750,000	1,000,000	2,000,000

TABLE III.—Rise of Temperature in Degrees Fahrenheit Produced in Rock by Various Stress Differences and Deformations (Specific Heat Assumed = 0.2).

Stress Differences in Feet of Rock Head	Deformation-Ratios = R.						
	1	$\frac{1}{2}$	$\frac{1}{5}$	$\frac{1}{10}$	$\frac{1}{20}$	$\frac{1}{100}$	$\frac{1}{1,000}$
1,000	1	10	14	19	25	30	44
2,000	9	21	28	39	50	59	89
5,000	22	51	71	96	126	148	222
10,000	45	103	142	193	251	296	444
20,000	89	206	296	385	503	592	888
50,000	222	514	740	1,007	1,257	1,480	2,220
100,000	445	1,028	1,480	2,014	2,514	2,959	4,439
200,000	890	2,056	2,960	4,028	5,028	5,918	8,878
500,000	2,225	5,140	7,401	10,070	12,570	14,795	22,195

Table II. gives the values of the stress difference as rock head for several values of H and I. This value of the stress difference is to be used to find the heat formed, from Table I, or the corresponding temperature increment, from Table III.

Neither Table I. nor Table II. is based on any assumptions; they are practically absolute. I have purposely constructed these tables in such a way that any person interested may place what value he pleases on H, I, and R and judge if the amount of heat formed, according to the tables, is sufficient to produce fusion.

The terms heat and temperature must not be confused. For example, to fuse 1 lb. of ice from and at 32° F. requires 143.5 B.t.u. of heat, but it does not require any change of temperature. The figure 143.5 is called the latent heat of fusion of ice in Fahrenheit units. An additional amount of heat is required if the material has to be raised to fusion-temperature before being fused. For ice it takes 0.504 B.t.u. for every degree Fahrenheit which 1 lb. of the material is raised before being fused. The figure 0.504 is called the specific heat of ice in Fahrenheit units.

As it is known that the earth is solid practically to the center, it follows that the fusion-point of rocks must rise with the depth so as not to be overtaken by the increment of temperature with depth which obtains in portions of the earth where metamorphism and vulcanism are not proceeding. If this were not the case, all rock magma below 150,000 ft. would be in a state of fusion.

If the deformation be measured on solid rock which has not been melted, the heat-values given in Table I. are the heats necessary to raise the temperature from that which is normal, at the depth where fusion takes place, to the temperature of fusion. After the fusion-point is reached and a small quantity of rock is reduced to the liquid state, the deformation takes place preferably in the semi-molten or pasty material, which is thereby superheated beyond the fusion-point. The melted rock immediately gives up its excess of heat to the surrounding rocks, and supplies the heat for fusing more rocks. Thus, if the stress-ratio (R), determined by measurement of schistose deformations around a batholith, is $R = \frac{1}{10}$, and if the rock head (H) is estimated at 100,000 ft., and the stress-ratio (I) at 2, the stress difference is seen from Table II. to be 100,000 ft. rock head, and the heat necessary to raise the temperature from normal (for the depth considered) to fusion-point (for the depth considered) is 296 B.t.u. This at a specific heat of 0.2 gives $\frac{296}{0.2} = 1{,}480°$ F. difference of temperature. If the fusion-temperature can be reached by the heat generated, it is clear from what has been said above that the latent heat of fusion will be forthcoming. I have therefore added Table III. showing the temperature increments corresponding to the various deformation-ratios and stress differences which bring the rock to fusion-temperature.

The heat necessary for the fusion of rocks must vary with the depth, and also with the kind of rock. The temperature of fusion is necessarily higher

in depth, but the latent heat of fusion will be less, and the natural temperature of the undisturbed rock greater.

At the surface, the normal fusion-point of igneous rocks is from 1,000° C. to 1,200° C., or from 1,800° F., to 2,200° F., and the specific heat from 0.2 to 0.3.

Others may place what limitations they think necessary on the various factors, but they will doubtless find that there is usually sufficient heat generated to account for igneous fusion.

EVIDENCE IN VOLCANIC HISTORY.

It has been found that, historically, a volcano generally begins with the ejection of a lava which is neither very base nor very acid in composition. It tends, in the course of time, either towards a very acid extreme or towards a very base extreme of lava composition.[12]

On the surface of the earth the basalts are the most fusible rocks, those which are either more basic or more acid being less fusible. With depth, however, there are two very important modifying conditions.

First, the solution of silica in aqeous material tends to lower the melting-point of the more acid rocks. The contraction [13] which takes place when this occurs accentuates this lowering of the fusion-point when high-pressure conditions are superimposed. Second, the greater expansion of the basalts at the instant of fusion makes them less easily fusible when under high pressure than rocks of mean acidity.

It is therefore probable that the first rocks which become sufficiently liquid to flow are those of mean composition, such as the andesites, and that only as these become exhausted is the metamorphism carried further and the less fusible rocks or rock-mixtures melted.

Many refractory rocks such as quartzites, clay slates, limestones, etc., obviously remain unfused, but it may often happen that fusion starts at the contract between two or more refractory rocks, and they may then continue to be melted down into a fusible mixture.

In a metamorphic region the most fusible mixtures afforded by the contacts are evidently formed first. After a while either the base or acid material becomes more or less used up and magma tending towards one of the extremes and at a higher fusion point and under greater stress has to be formed.

Finally the stress necessary for fusion at this center becomes so high that the adjacent regions of unmelted rock reach the fusion temperature and relieve the stress. The refractory residue of the old center of fusion then ceases to be fused any further.

Mountain chains have a great degree of permanence. This can be explained on the sassumption that underneath them are zones of weakness in the earth's crust which make it yield by plastic flow and fusion.

An obvious cause which can be assigned for such weakness is the heat generated by plastic flow. Such heat would render further plastic flow and fusion more facile, so that the mountain chain would support itself in one position in spite of rapid denudation or creep gradually in one or both of the directions at right angles to its axis.

In great bathyliths there is generally evidence that the rocks surrounding the igneous cores have been nearly in a state of fusion. These rocks are usually of gneissic or schistose character, showing much plastic flow and changing gradually into the igneous material.

It is rare on obviously intrusive igneous contacts not to find a very sharp line as between intrusive and wall-rock.

W. S. Bayley has described a small occurrence at Pigeon Point, Minn., U. S. A.,[14] where there is igneous fusion at the contact between acid and base igneous rocks (keratophyre and gabbro). The locally-fused rock has a composition between that of two parent rocks and grades into each of them. It was unusual that metamorphic forces should have been brought to such a pitch as to cause the necessary rise of temperature for fusion in this case and then have been released before they had melted the country for miles around.

As I have shown elsewhere,[15] the lava intruded in the regions where the horizontal stress exceeds the vertical, takes a horizontal tabular form and raises the superincumbent strata. These upper strata ultimately become convex enough [16] to overcome their excess of horizontal stress and the lava then breaks vertical rents upward for itself. As it gets nearer to the surface the aqeous vapors and other gases which it contains expand very greatly, and the column of lava is thereby so much lightened that the whole, or part, of the liquid contents of the horizontal cavity are rapidly extruded. The surface then subsides [17] again and the vertical openings are sealed. When a sufficient amount of lava has again accumulated in the laccolith form it is again extruded, and so on again and again.

In the absence of aqueous vapors and other gases, the pressure may be just enough to extrude the material slowly and regularly as "Fissure (Massive) Eruptions." [18]

The calculated position of the seat of a volcanic earthquake is not necessarily coincident with the place of formation of the magma. The earthquake is more probably due to the above mentioned extrusive effects occurring at less depth.

COMPOSITIONS OF ERUPTIVES.

The idea that igneous rocks are identical with ancient surface and intrusive formations is an old one, but geologists were not generally prompted thereby to conceive that bathyliths were not intrusions, but igneous sources.

The mean composition of the material issuing from a volcano is strikingly like that of the fusible sedimentary rocks. The lava corresponds to ordinary surface-rocks in fusible proportions. The steam corresponds to the water of their pores, the hydrocarbons to some of their coal and mineral oil; the chlorine closely suggests the sea-water which they often contain, and nitrogen suggests nitrates and dissolved nitrogen.

It therefore appears, according to this hypothesis, that gold and its siliceous rock associates may have been brought together at the surface as sand and gravel-deposits, from which all the more easily decomposed minerals, which also happen to be the more base minerals, have been washed.

The same reasoning may apply to tin, though in a lesser degree, a more delicate adjustment of conditions being necessary for the deposition of this metal.

Silver, though in many ways an associate of gold, also occurs as a constituent of base minerals which are easily slimed, and which, in the course of denudation, find their way to the sea, where they may settle with the fine sediments. These have usually a composition approaching that of the more base igneous rocks.

It is not as easy to explain the circulations of copper. Being an exceedingly soluble metal, however, it may find its way to the sea as a solution, being precipitated in very small quantities over vast areas.

Lime is precipitated in a similar manner, and its calcium is often partly replaced by magnesium.

This selective resemblance of copper and magnesium may explain the frequent association of the two elements in igneous rocks.

Sulphur, from the sulphides, having become a sulphate or sulphurous salt, is also very soluble, but is ultimately redeposited, often as gypsum. From this state it is probably reduced by carbonaceous matter.

This carbon becomes buried in considerable quantities with the sediments, and probably induces the highly reducing nature of all eruptives and their emanations and the CO_2 which occurs in the latter.

It is well agreed that sediments have been brought down to depths where severe metamorphism goes on. It is only a minute step more to fusion.

The oldest rocks we know of as sediments do not go far beyond the history of life on the earth's surface. Before this time there must have been a vast period when water was too hot for life, atmosphere pressure was greater, and the physical commotion of land, water, and atmosphere enormous. It therefore follows that a vast amount of churning up of rocks, and incidental concentration of their minerals, must have occurred before the dawn of known stratigraphical history. These rocks are now doubtless fused or metamorphosed beyond recognition. Indeed, without life we know or no way by which they could be identified.

The Decadence of Utah Copper

We are reproducing the following article from L'Argent of Paris, and dated Wednesday, April 4th, just as it apeared in that journal. It is composed largely of the comment of Mines and Methods on the fourth quarterly report for 1912 of the Utah Copper Company, but it reflects perfectly the French opinion of that concern's peculiar methods of publicity. Referring to our comment on the report L'Argent says: "That excellent review, Mines and Methods, gives us another sound of the death-knell of Utah Copper, and we are glad to be the first to give our readers the comment of a confrere always well informed and of a competence which we do not have to praise."

La décadence de la Utah Copper

Pour masquer la situation réelle, la Compagnie a recours à des procédés spéciaux de comptabilité ; d'autre part, l'exploitation est gravement entravée pendant la période d'hiver, fait important que l'on a toujours caché aux capitalistes français.

A la faveur d'une réclame tapageuse, les intéressés étaient peu à peu parvenus à persuader à nos capitalistes et même aux milieux financiers français que la *Utah Copper* était une véritable merveille moderne. La vérité était d'autant plus difficile à discerner que l'on ne connaissait de l'affaire que ce que les promoteurs voulaient bien nous en dire. L'excellente revue *Mines and Methods* nous donne un autre son de cloche et nous sommes heureux de réserver à nos lecteurs la primeur des commentaires d'un confrère toujours bien renseigné et d'une compétence dont nous n'avons pas à faire l'éloge.

Le rapport de la *Utah Copper*, pour le quatrième trimestre de 1912 a été publié vers la fin février. C'est un document au moins bizarre, qui laisse les actionnaires rêveurs, en même temps qu'il donne passablement de fil à retordre aux porteurs de titres désireux de se faire une idée exacte de ce que l'entreprise réserve pour l'avenir. Lorsque ces derniers liront les histoires à dormir debout qui précèdent l'aveu que fait la direction d'un déficit qui ne s'élève pas à moins de $ 82,247 (423,575 fr.) pour le trimestre, et quand ils se seront aperçus des précautions dont l'exposé du bilan a été entouré, il est probable qu'ils s'étonneront de ne pas trouver un déficit encore plus considérable, eu égard à la façon dont est établi le compte profits et pertes.

Le bilan montre en effet qu'il a été extrait 930,595 tonnes de minerai d'une teneur de 1.104 0/0, soit 22 livres de cuivre par tonne. Le poids en cuivre brut a été de 12,906,582 livres et le coût de production ressort à 14 cents 83 par livre. (Le cent vaut 5 centimes ou 1 sou pour la commodité de la comparaison.) La valeur moyenne du cuivre au cours du trimestre écoulé a été de 15 cents 15 par livre. Le bénéfice apparent provient de la différence entre 14.83 et 15.15, soit 0.32 d'un cent par livre. Si l'on multiplie cette différence par le nombre de livres de cuivre produites pendant le dernier trimestre, on obtient un profit net de $ 39,273.18 (200,000 francs environ) qui est le chiffre indiqué dans le bilan comme représentant le bénéfice du travail des moulins.

Mais comment se fait-il que les moulins puissent donner des bénéfices, lorsque les autres branches de l'entreprise ont tout mis en œuvre pour rompre l'équilibre et accuser une balance déficitaire ? La question est d'autant plus difficile à résoudre que dans aucun bilan trimestriel on n'avait jusqu'à ce jour crédité de bénéfice spécial le chapitre des opérations effectuées par les moulins. Le profit qu'on met en vedette, divisé par le nombre de tonnes de minerai traité — ou soi-disant tel — fait apparaître un profit *d'environ 4 cents par tonne, soit 20 centimes.*

Ce qu'il y a de plus remarquable dans ce bilan, c'est que le métal semble avoir été récupéré sur une base de 14 livres de cuivre par tonne de minerai traité, soit environ 68 0/0 de la teneur du minerai, et cela en face d'une moyenne de moins de 60 0/0 obtenue antérieurement, même dans les conditions les plus favorables. Ce progrès, qui apparaît d'ailleurs comme absolument hors de rapport avec les conditions habituelles, disparaît lorsqu'on se prend à considérer que près de 1,300,000 tonnes de minerai ont été, en réalité, traitées au cours du trimestre, soit près de 30 0/0 de plus que le chiffre donné dans le bilan. La différence est représentée par ce que la direction appelle l'excès de teneur du minerai en eau, par suite des conditions atmosphériques éminemment défavorables. On ne pourra toutefois s'empêcher de penser que si cet excès de tonnage n'avait pas été mis en ligne de compte dans le but de permettre à la direction de faire valoir un progrès dans la proportion de métal récupéré, le bénéfice serait *inférieur à 4 cents par tonne.*

Une autre conséquence malheureuse, due aux circonstances climatériques défavorables et au froid, semble avoir été la suivante : il a fallu faire passer sous les pilons jusqu'à 50,000 tonnes par jour afin de venir à bout de la résistance opiniâtre offerte par le minerai congelé, alors qu'il est reconnu que les minerais de la *Utah*, à la température ordinaire, sont absolument friables et faciles à traiter. Selon les dires du directeur Jackling, pour obtenir un pourcentage de métal récupéré par le travail des moulins dans des conditions vraiment économiques, il faut s'attacher à le déterminer purement et simplement par le nombre de tonnes de minerai qui peut être engouffré dans les moulins. Il est donc à supposer que lorsque les conditions climatériques se seront améliorées, il sera nécessaire de relever le nombre de tonnes broyées par les moulins pour le mettre en rapport avec celui de la section des pilons. L'augmentation ainsi obtenue n'aura lieu que par temps favorable et on se réservera de faire donner aux pilons, dont le nombre sera augmenté, leur effort maximum lorsqu'il s'agira d'assurer à l'établissement une quantité suffisante de matière traitable aux époques où le minerai sera rendu plus résistant par suite de la gelée et du froid.

Voici encore quelques points sur lesquels une lecture attentive et réfléchie du bilan ne manquera pas d'attirer l'attention:

Pourquoi la Compagnie a-t-elle suspendu le travail alors que la direction savait pertinemment que cela entraînerait non seulement une perte immédiate d'argent, mais encore celle de plus d'un million de tonnes ?

Et si ce que le directeur Jackling a dit le mois dernier est l'expression de la vérité, c'est-à-dire qu'il faudrait encore deux ou trois mois pour revenir aux conditions normales, voulant faire par cela même allusion aux événements qui se sont succédé depuis le commencement d'octobre dernier, pourquoi le travail continue-t-il à l'heure actuelle ?

Il n'y a, en réalité, aucune excuse à la manière de procéder à la fois dispendieuse et ruineuse, qui prévaut à l'heure actuelle au sein de la *Utah Copper*, et cela depuis cinq mois, ou pour le point de vue spécial qui nous occupe, et pour mieux dire, depuis le début. On pourrait cependant trouver cette excuse dans la volonté très nette d'éviter le plus longtemps possible de rendre des comptes.

La situation est désespérée. Il semble bien qu'il n'y ait pour la *Utah Copper* aucune échappatoire désormais, aucun moyen d'éviter l'orage qui se prépare et dont les nuages menaçants s'accumulent de plus en plus. Cette affaire s'était elle-même définie comme devant être « la merveille du siècle ». La direction se présentait comme la quintessence de la perfection et les ingénieurs n'étaient rien moins que les premiers du monde. Les méthodes de sondage et de traitement du minerai avaient été célébrés comme le dernier mot du savoir humain et de la science appliquée. Le succès de nombreuses autres entreprises colossales autant que gigantesques, que la direction avait patronnées, les résultats mirobolants qu'elles ne devaient pas manquer d'amener, avaient été proclamés et annoncés comme devant former la vigueur et l'excellence de la *Utah Copper*.

Si l'on voulait représenter d'une manière concrète et frappante le chef-d'œuvre réalisé par ces cerveaux d'élite, par ces hommes géniaux, par leur habileté professionnelle, tant au point de vue des opérations minières que financières, il faudrait se représenter une pyramide renversée dont la *Utah Copper* constituerait la base, et construite avec des blocs énormes de béton formés de quantités disproportionnées de sable, de ciment, de gravier brut et *d'eau*, de cette *fameuse eau* dont on nous a tant rebattu les oreilles. Et on doit alors se demander comment cette pyramide pourra tenir debout ?

—o—

Experience in the Use of Water Power

By C. M. MYRICK.*

The following notes are submitted in the belief that they may interest some of the many owners of small water power plants, so generally used in mining work throughout the west.

A small and somewhat primitive mill was taken over by a leasing company, and a 10-stamp battery was installed. Originally, power had been furnished by a Pelton wheel; but since the supply of water depended on the rate at which snow was melting on the mountains, a steam plant had been added to help out during cold spells. This auxiliary plant was anticipated and expensive to operate, and, soon after starting up the remodled mill, it broke down completely; so that it became necessary to get all the power possible out of the Pelton wheel, with its ever-varying water supply.

The pipe line, about a quarter of a mile long, was made up of assorted sizes, from 7 to 11 inches in diameter; and, since it was buried deep under snow, there were no data from which to calculate the theoretical size of the nozzle. The stream being at this time at a low stage, it was important to make the most efficient use of the available water. This was done by using a nozzle large enough to pass the whole supply—taking care, however, to limit the size so as not to lower the water level in the tank at the head of the pipe line.

As the weather became warmer, the nozzles were gradually enlarged to meet the increasing volume of water; but a point was finally reached where further enlargement only gave decreased power. Evidently the loss from friction had more than balanced the gain from the increased flow through the pipe. However, the area of nozzle that developed the maximum power from the pipe line had been found. This was used; and the surplus water was allowed to run to waste at the head of the line.

All this experimenting necessitated the trial of nozzles of many different sizes; and, since these were not on hand, they were improvised as needed. Fig. 1 shows the quick and easy way in which this was done. A hole, 0.25 in. deep and of just the diameter of the outer rim of a cast iron nozzle that had been found too large, was bored into a plank. Then, using a bit of the size desired for the new nozzle, the hole was continued through the plank. A tapering wooden plug, 8 or 10 ins. long, was made to fit into this hole. The cast nozzle was forced into the shallow cut in the plank, the inner plug put in place, and the space between plug and nozzle filled with babbitt metal. The wooden plug being removed left a nozzle of the desired diameter. When this particular size was no longer needed, the babbitt bushing was easily removed by heating.

To determine the relative power furnished by the different nozzles, it was only necessary to count the number of drops of the stamps—a method which may seem somewhat crude, but which certainly showed the effective work being done.

In order to get a record of the pressure under the various conditions, the pipe was tapped close to the nozzle, and a steam gauge, taken from the boiler, was attached. The notebook containing a memorandum of these tests was destroyed in the great fire at San Francisco; but the general facts are: that, with the valve closed, the static pressure in the pipe was 60 lbs. per sq. in.; that, no matter how much water was available, it was harmful to use a nozzle larger than 2⅜ ins.; and that even a change of 1-16 in., either way, caused a perceptible slowing down of the wheel.

Discharging through this 2⅜-in. nozzle, the pressure stood at 40 lbs.; or, in general terms, water from this pipe line was yielding its maximum power when one-third of the head was lost in overcoming pipe resistances. Subsequent consultation of authorities showed that this agreed very well with the results obtained from the theoretical treatment of such problems.

Care was taken during the trial to lag up the pulleys, so that the circumferential speed of the water wheel approximated to one-half the velocity of discharge from the nozzle, calculated from the effective head. It was noted, however, that a small variation was not important.

Incidentally, these experiments demonstrated that there was a very considerable waste of power, if the cam faces were not kept properly greased; and that this loss occurred long before the cams were dry enough to throw sparks. On the other hand, there was no necessity of excesive lubrication, incurring the risk of having grease thrown on the amalgamating plates.

*Transactions of the American Institute of Mining Engineers.

FORMATION AND GROWTH OF DISSEMINATED COPPER DEPOSITS

By JAMES O. CLIFFORD.

The great importance of the low grade disseminated copper deposits of the United States is best illustrated from the fact that at present considerably more than half of the total copper metal output of our mines is won from the ores mined therefrom. The failure to find additional bonanza mines during the past decade clearly indicates that our future supply of tht red metal will doubtless be derived largely from the so-called porphyries.

Generally a disseminated copper deposit is understood to be a large body of low grade ore, ranging from one to three per cent copper per ton, which, under the most satisfactory economic conditions, can be operated to a profit. The economic phase is all important. This is best illustrated from the fact that, contrary to many statements published during the past year to the effect that copper could be produced from the "porphyries" at a cost of less than seven cents per pound of refined metal, the general average production cost ranges from 10.5 cents to 14.9 cents per pound. It will be noted, therefore that there are several of the porphyries that could not be operated to a profit on an average market price of 13 cents per pound copper. It should be considered in this connection that there are numerous large undeveloped disseminated copper deposits in various parts of the world which are, in point of prospective ore tonnages and general average copper content per ton, far superior to our present largest "porphyries." These last mentioned properties should, in due time enter the list of producers under most favorable circumstances.

Geologically the disseminated copper deposits consist of a large mass of mineralized rock material resulting from the general impregnation and replacement of large volumes of rock by cupriferous pyrite. The several important developed properties present many interesting features in connection with the mode of ore deposition, and, while they are analagous in a general way, they are widely different in specific relation. However, it is the object of this paper merely to outline the more important phases of the situation, without calling especial attention to any individual property, only as incident to the presentation of criteria.

ESSENTIAL CONDITIONS IN FORMATION OF OREBODIES.

Two conditions seem to be particularly essential to the formation of extensive bodies of disseminated orebodies: First the presence of extensive areas of sedimentaries and, secondly, the contact metamorphism thereof through the agency of magmatic intrusions. Both the sediments and the intrusive magmas of individual properties wherein commercial ore deposits occur are of widely different character. There is, or rather, there does not seem to be, a particular type of intrusive necessary to the primarly mineralization of the district wherein the disseminated deposits are found. These conditions vary in different parts of the world. It is assumed, that the majority of the disseminated orebodies already developed owe their origin to intrusives represented mainly by rocks ranging from granites to monzonites in composition. This is true of many deposits, but not of all.

The present tendency is to regard the igneous rocks, either directly or indirectly, as the ultimate source of the metals. Two hypotheses advanced covering the primary ore genesis are (a), the theory of the inclusion of metallic minerals as accessories in the igneous rocks themselves, and the subsequent extraction and segregation of the ore materials through weathering processes and (b), the production of metalliferous bodies in connection with rock masses in a metallic state, either through magmatic secretion or by the expulsion of the volatile compounds of the metals during the process of magma cooling.

Ore segregation from already solidified igneous rock masses involves processes and conditions very different from those obtaining in the case of cooling rock magma wherein the metallic compounds are being expelled in volatile form and collect around the margins of the slowly cooling molten mass. The metallic content of unweathered igneous rocks are completely locked up in them, and they may be released through weathering, or through metamorphic change below ground-water level. Where not exposed to weathering the contribution of metals to the formation of orebodies is small, but through exposure to the elements the quantity of metals liberated by the degradation of the rock mass, in the aggregate is great.

MAGMATIC ORIGIN OF METALS.

In considering the magmatic origin of metals, and the association of ore deposits with cooled magmas, investigations have resulted in the determination of the presence of ore-forming materials as a general diffusion through molten magmas, in which minerals containing the important commercial metals have been found present in igneous rocks which apparently had solidified from a molten state.

Further, it has been noted that, under the high temperature and great pressure obtaining at the time of intrusion, the mineral compounds doubtless existed in volatile form. The later cooling of the magmatic mass resulted in the expulsion of the greater part of the contained metals into the surrounding or overlying rock series, which accounts for the fact why so many metalliftrous deposits, and particularly the porphyry deposits, are found at and above the line of contact of the igneous mass and the rock series through which they break. The segregation of the dissolved metals in magmatic masses occurs through a process of differentiation during the period of cooling and later solidification of the mass.

During this process following the expulsion of the metallic content of the cooling magma, the mineral components of the mass undergo a change resulting in the first instance in the formation and segregation of the accessory rock constituents which, together with a small percentage of the original metallic content of the magma, crytallize out.

PROCESS OF DIFFERENTIATION.

The differentiation of ores from magmas is especially interesting, though the attention the subject merits has not been given it. In the instance of metallic differentiation, represented by the occurence of extensive bodies of iron, lead, zinc, in local profound development along the marginal facies of the original magmatic intrusion seems to depend entirely upon a composite of static, cooling, and crystalline differentiation. This seems to be true particularly in the case of the porphyry coppers where an almost perfect segregation of the orebodies of metals other than copper occurs. The best explanation of the situation seems

to be that the magmatic minerals, exceptionally rich in metallic sulphides, is subjected to static differentiation in the lower depths of the earth, followed by further differentiation through cooling during ascent towards the surface of the earth, and finally the crystalline differentiation which results in the final segregation and concentration of the orebodies along the margin of the cooling magma.

The final concentration of metallic sulphides appears oftentimes as a large distinct orebody (as in the instance of the Hanover-Santa Rita deposits of iron and zinc ores, and the extensive zinc blende deposits in the Butte district) of high-grade ore. In many instances, however, there apparently has not been a completion of the processes of segregation and concentration, due to the too rapid solidifying of the magma, in which event the product of concentration is relatively small.

An example of this latter state occurs northwest of the Hanover district, New Mexico, where the original mineralization consisting of iron, copper, zinc, and lead sulphides occur in the limestone series overlying the quartz-monzonite porphyry which is considered to be the source of the mineralization of that area extending through from Santa Rita northwesterly into the Copper Flat district, a distance of several miles in length, and two miles in width.

Similar occurences have been noted elsewhere but the district mentioned is taken as an example in view of the fact that it presents a combination of both circumstances wherein there has been a completion of the process of concentration of the original metallic sulphides of the intrusive magma, as well as a presentation of conditions relating to a state of the original unaltered igneous rock at its point of contact with the overlying sediments.

MAGMATIC SEGREGATION.

Among other considerations governing the processes and the conditions attending the segregation of the several ore-forming minerals incident to igneous intrusions are the resultant lines of weakness developed in the earth's crust when, through mountain-making movements, the molten magma is forced upward and the rocks which it traverses are more or less extensively displaced as well as fractured and brecciated. Further, the cooling of the molten body of magma results in shrinkage of the mass and produces cracks and crevices both in the hardened margins and oftentimes in the overlying rock series.

The result of this condition is that gases from the interior are extruded into the crevices both of the solidified margins of the igneous mass and of the surrounding rocks into which the intrusion has taken place resulting in the formation of extensive deposits of high grade ore in the form of fissures within the igneous rock itself, and continuing outwardly into the overlying sediments (where present) and producing enriched ore zones both in the form of lenses or chambers occasioned by replacement of the limestone, and as areas of concentration along the planes of contact.

In the case of the disseminated replacement copper deposits slow cooling of the intrusive mass is preferable as it results in the more uniform fracturing of the igneous rock, and consequently a more diffuse mineralization of the overlying rock series. Acid intrusives seem to result in a more thorough and uniform fracturing and mineralization of the rocks, whereas basic istrusives generally develop main fissures resulting in the localization of the minerals as vein deposits rather than a dissemination of the metals. In this connection while the factor of brittleness based upon the relative percentage content of silica and iron is in part the determining factor, other equally important features are the physical conditions accompanying the intrusion which doubtless play the most important role insofar as the question of localization or dissemination of the primary ores are concerned.

Of particular importance is the determination of the zones of greatest strains and fracturing as these factors govern the channels of circulation of the mineral-bearing solutions and the location of the ore deposits. Excessive strains produce fault-vein systems in addition to minor fracturing resulting in a combination of governing fissures and associated contact-deposits of disseminated ores.

FORMATION OF DISSEMINATED DEPOSITS.

From what has been outlined the general conditions governing the intrusion of magmas into the overlying rocks with attendant mineralization either as a uniform dissemination of the contact zones, or as a localization of ore deposits due to the development of main fissures, the subject of the formation of ores bodies of the disseminated porphyry type now can be taken up.

The fulfilment of two conditions seem to have been necessary during the process of primary mineralization; the intrusion of a magma rich in metallic sulphides into overlying sediments, resulting in the mineralization of the latter; the complete or fractional fissuring of the igneous rock through slow cooling with attendant expulsion of metallic salts. Dependent upon specific physical conditions, and chemical components of the intrusive, the result of primary mineralization was either the complete dissemination of the primary metallic sulphides into the overlying rocks, or the localization of ore bodies in main fissures cutting both the sediments and the igneous rock. Throughout the sedimentary series seem to have played as important a part in the formation of the orebodies as the original mineral-bearing intrusive. From a general review of the geological conditions surrounding the so-called "porphyry" deposits it is quite apparent that, while the general view seems to follow the theory of uniform dissemination, the evidence afforded points more to a composite of localised zones of enrichment in which the dissemination of the primary mineralization was of minor importance. In other words the concentration of the metallic salts extruded from the cooling magma quite generally resulted in the formation of replacement and contact-metamorphic deposits in the superincumbent sediments, and as vein deposits in the igneous rock itself. The dissemination of the contact zones was apparently of secondary importance. However, considered either from the point of view, either of localized or disseminated area following the original mineralization, the ultimate result, in so far as the formation of deposits of secondary enrichment are concerned, would have been the same, but the former condition of a localization of orebodies rightly should be given more consideration than it has heretofore been accorded.

SECONDARY SULPHIDE ENRICHMENT.

In discussing the subject of secondary sulphide enrichment as applied to the disseminated replacement copper deposits the following order will be observed: (1), General Nature of Process; (2), Structural Relations Governing Deposition; (3), Climatic and Topographic Conditions; (4), Physical and Chemical Processes; (5), Types of Deposits.

The reader can assume the original mineralization resulting from the igneous rock to have resulted in either the formation of localized deposits of cupriferous pyrite, or as a uniform dissemination of the mineral in the form of a contact-metamorphic deposit, or as a mineral-bearing volcanic extrusion. The ultimate result of the disintegration of the rock followed by the oxidation, transportation, and later precipitation of the metallic content will be the same.

The primary result necessary for the commencement of secondary enrichment is that the metal-bearing rock mass be subjected to weathering processes, in-

volving the degradation of the rock material, the oxidation, transportation, and subsequent precipitation of the metallic content. Further, there must be well-defined channels of movement for the metal-bearing solutions to insure the uniform distribution necessary to the formation of ore deposits. If the underlying rock mass affords a condition of uniform fracturing, with a minimum of large fissures and fault planes, the result will be the formation of a disseminated ore body of a comparatively uniform copper content; if the area of brecciation, or fracturing, is limited in extent, and the channels for the transportation of the metallic salts in solution are confined mainly to large fissures, the result will be the formation of enriched zones of ore, or a localization due to secondary enrichment. Types representative of comparatively uniform dissemination, localization, and a composite of both types of orebodies are common.

NATURAL RESULTS OF PROCESS.

Generally the process of secondary enrichment develops zones of oxidation solution, and precipitation, in addition to the original upper area of the igneous intrusion, or zone of primary minerals, occuring in descending scale in the order named. There is a gradual merging of each respective zone into the one following, so that the line of demarkation between the respective zones is difficult to determine. In the zone of oxidation there often appears an iron cap, composed of hematite or limonite. Residual gold as a concentration product, and often silver salts are found therein. Immediately below this surface zone of oxidation there occurs a zone of leached material containing appreciable quantities of lean pyrite ores, and often gold and silver in a lesser degree of concentration than in the preceding zone.

Directly underlying the zone of leached material which may be two hundred or more feet in thickness, is the zone of oxide enrichment. This latter zone represents the occurence of the more thoroughly oxidized ores, native elements oxides, carbonates, sulphates, and silicates. Following this zone is that of the secondary sulphides. Insofar as the formation of commercial orebodies of the disseminated replacement type are concerned, this zone is of especial importance. The thickness of this zone varies, and is dependent, as are all the others upon the rate of erosion and the quantity of copper minerals which have been leached from the overlying strata and therein concentrated. There is no definite depth to which this zone extends, and by no means is it dependent upon the upper limit of water level. The zone of primary sulphides occurs immediately under the zone of secondary enrichment, and is of variable thickness.

The depth to which secondary enrichment has penetrated is dependent upon many conditions. Of these one of the most important is the rate of erosion of the upper or original orebodies, and the depth of the brecciated or fissured zone of the primary ore area. In this connection however, the depth to which secondary enrichment has penetrated quite generally is taken as the point of limit of ores of commercial grade, although evidences of enrichment might occur at much greater depths.

It should be considered, in relation to the process of secondary enrichment, that the principal governing factor is the rate of erosion referred to the original copper mineral content of the overlying orebodies, relatively to the copper content of the ores in the primary zone. Contrary to the general supposition that enrichment ceases at ground water level, it is pertinent to observe, that while surface water partly is responsible for the occurence of secondary enrichment of ore deposits, and erosion of the area containing the original mineralization exposed to weathering can be thoroughly effected only through the agency thereof. The predominant factors are the physical and chemical characteristics of the rock series and mineral-bearing solutions relatively to the intensity of circulation regardless of any definite water level.

In the southwestern porphyry areas the climatic conditions are semi-arid, and the rate of erosion comparatively slow. Under present conditions, therefore, the time required for the concentration of the metallic salts of the upper areas would be lengthy so that, unless we assume the conditions as outlined in the preceding paragraph, we might expect the occurrence of orebodies representative only of the original mineralization; excepting, of course, the occurrence of high grade ore-deposits formed in the manner hereinbefore indicated.

In reference to the original volume of metallic salts contained in the contact-metamorphic, fissure, or replacement zones of the enrichment, little can be said. It is certain, however, that the quantity of such metallic salts returned to the intrusive as sources of secondary enrichment represents but a very small percentage of the original volume extruded. That is the peculiar circumstance which makes it almost certain that erosion of the overlying rock series was intensive. Should we assume a condition wherein the general average copper content of the overlying rocks was the same as that at present indicated in the primary ore zone, the percentage content of the metallic salts returned would be trivial. In short, assuming the general average content of the primary ore zone (the igneous rock responsible for the mineralization) to be 0.3 to 0.7 per cent copper, the volume of material overlying the intrusive to contain similar percentages then allowing an equal thickness for the mineralized areas of both rock series, the probable return of metallic salts for the purpose of secondary enrichment would not exceed five per cent. of the total. Therefore, for the formation of a disseminated deposit averaging two per cent copper per ton, there would be required an area of mineralization ground of the same general copper content as the primary ore zone equivalent to twenty times the area of the zone of secondary enrichment.

This outline of the relative volumes required for the formation of commercial deposits of disseminated ores is subject to further consideration. Under the law of progressive erosive action it must be considered that, following each successive stage of concentration of minerals through the several stages of leaching, the average content of the next lower horizon is increased, and in turn exposed to weathering, and it follows that each successive exposure of enriched ore undergoes serious mineral losses, so that, in finality, the total quantity of copper mineral required in the process of enrichment of the orebody is considerably greater than the estimate of twenty volumes above mentioned.

CHICKENS IN SMELTER FUMES

A member of the State Legislature from down state was spending the winter with a sister near Murray, her chickens were of great interest to him, as they were kept in city houses with never a glance at the sky.

"Why don't you let them run free," he asked her one day.

"If I did I wouldn't have any by Thursday evening; they eat too much smelter smoke that scums the ground over when it settles. O no, you can't see it on the ground, neither can those Rhode Island Reds, but they go about picking up everything that's loose in the way of eatables, and then they get diarrhoea, and then the ax when I feel real humane towards them, for they cannot get well while running in an open lot."

And then she revealed to the legislator a few of the tricks of the chicken trade. Her records showed that more than half her chickens died when left in open lots to feed; when fed under a shelter, but left to scratch and roam in the open, many still died, but the loss was appreciably less; she soon found that by raising them on the apartment house, or

city's "flat" system, where no hen can get to the uncovered ground where the smelter fumes settle she never lost a head from that kind of sickness.

"O, yes," she told him, "I did lose eight or ten one week from that trouble since they were boxed up, but one day during that time I caught a hen drinking from a puddle through a crack in her box and that settled it in my mind; that puddle was made by the rain water washing down from the roof, and the roof was coated with poison." And the few folks that do raise chickens in the poison belt are said to have had similar experiences with their chicken growing.

Another Magnetic Prospector

That gold, silver and other rare minerals can now be located by the attraction of the magnetic needle is the startling announcement in the Deadwood Pioneer-Times, says the Engineering and Mining Review. No, the Stauffer brothers have not moved their "Spanish needle" plant to the Black Hills. Local talent has been drawn upon. The inventor, accordig to the Deadwood paper, is C. D. Berg, of Lead, S. D., and he has perfected an instrument, the "forceful electromagnetic oscillations or vibrations of which over an ore deposit are simply wonderful." The inventor reports that he was first confused by the attraction of many different minerals so that he could not distinguish one from another but subsequently learned how to discern the different kinds of minerals "even to three or more different kinds of minerals in one ore." A demonstration of the instrument was given by the inventor, "whose body constitutes a great part of the instrument."

We quote the observations of the Pioneer-Times: "Picking up his instrument, which consists of a battery suspended to an electric cord, the other end of which cord is provided with a metallic handle, or rather a dry-cell battery with a handle, which he firmly held in his hand, Mr. Berg placed it over a piece of gold-bearing ore, and immediately the instrument began to oscillate over the ore. He then told us to watch him closely, and proceeded to place a small bit of some material between his teeth. While holding this material between his teeth and being careful to keep his lips from coming in contact with it, the instrument would work uninterruptedly, but the moment he closed his lips against the bit of material and the flesh part of the lips came in contact with it, the current evidently emanated from his body and was immediately cut off and his instrument ceased to work while the circuit was thus cut off."

Like many other inventions, its success seems to depend upon the constancy with which the inventor can keep his mouth open, writes a Black Hills metallurgist. Another curious feature about these wonderful devices is that they develop such affection for their inventors that they refuse to work in any other hands. It is fortunate that the inventors are of an altruistic temperament, which prevents them from going out and locating all ore deposits for themselves. Still they may not be averse to disposing of an interest in their invention to others, and we wait with bated breath the announcement that two or three more Homestakes have been located in the Black Hills.

SUBURBAN WEATHER STATIONS

—A little more than a year ago, government weather instruments were exposed at Midvale, about one hundred and fifty feet above the level of the streets of the business section of Salt Lake City, and twelve miles south; about the same time a similar weather equipment was installed on a high farm at west Granger, twelve miles southwest of Salt Lake City, and about three hundred and fifty feet above the level of Main Street and Second South street intersection. The thermometers at these places are standard Weather Bureau pattern, maximum and minimum self-recording instruments, and are exposed in regulation shelters, making and equipment and an exposure almost exactly like the equipment and exposure of the official apparatus in this city.

The records for the calendar year 1912 show mean annual temperatures at Granger of 48.2 deg.; Midvale, 49.5 deg., and Salt Lake City, 50 9 deg., or a difference of 2.7 deg. between Salt Lake City, under the city and smelter smoke, and Granger, above the usual limit of the valley smelter smoke.

The effect of the city smoke combined with the smelter smoke makes this difference of temperature but the difference between Granger and Midvale is caused alone by the smelter smoke, apparently, and amounts to 1.3 deg., or just about one-half of the total influence in Salt Lake City, showing the entire lower portion of the valley to be more or less effectively smudged by smelter smoke.

In January, 1913, when city fogs and smokes were so numerous in Salt Lake City, the Salt Lake City mean temperature was 26.9 deg.; Midvale, 24.6 deg.; and Granger, 22 6 deg. The difference between Salt Lake City and Granger is 4.3 deg. for this foggy month, and the difference between Granger and Midvale is just 2.0 deg., or nearly one-half the total difference shown between Salt Lake City and Granger.

Therefore, it will be seen that while the City of Salt Lake has learned the lesson of smudging very well, from the Utah Fruit Growers, the valley, also has done about one-half as well, though it covers twenty times the area and has only two or three smoke stacks (smelters) to look after its interests.

FREEZING OF ROCK DRILLS

Freezing at the exhaust of rock drills, due to the sudden expansion of compressed air, and the consequent deposition of entrained moisture, is sometimes a cause of serious delay in winter drilling. Numerous expedients are available to overcome this difficulty. The most satisfactory is to place a water trap near the drills at a low point in the air line, in which the water carried in the air may be condensed and the air thus dried. Reheating of the air is also valuable; and in addition, secures an increase in efficency. Another method is to provide the drills with valves having a larger clearance. Valves for use with steam are often furnished with air drills because they are ground with a smaller clearance in the valve chest than the regular air valve, and are, of course, more economical. When freezing is threatened, air valves, with a clearance three or four times greater, should always be substituted. When reheaters and water traps cannot be used, cup grease has been found effective. The grease is fed into the machine about a cubic inch at a time through the throttle, and one application per shift is usually sufficient to prevent trouble from freezing. The grease should be about the thickness of heavy vaseline. Wood alcohol has also been tried but its effect is not so lasting as that of the grease. New drills are more susceptible to freezing than those that have been in use a week or two and are well limbered up.

The Evening Telegram says it understands—again—that the Utah Copper is dickering for Ohio Copper and Heinze's Mascotte tunnel. The hitch seems to be that Heinze don't care to trade Mascotte tunnel stock for Utah Copper shares; he wants the Utah company to sell the stock and give him the money. And that would be all right "if we could sell the stock."

Copper mines near Huelva, in Spain, where the Rio Tinto is situated, employ about 10,000 laborers, and in 1911 the output was over 1,000,000 tons of pyrite and 17,657 tons of copper ingots.

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CONTENTS: PAGES.

According to a local paper Samuel Newhouse was interviewed by the Boston Post the other day. After designating him as "the father of copper mining" in this state, the reporter made him say, among other things: "Our state is young as far as development of resources goes. When I went there fifteen years ago, and said that the properties carried paying quantities of copper, I had but little support, yet I saw the great Bingham camp grow from a production of 150 tons of ore per day to 20,000 tons a day."

When Mr. Newhouse went into Bingham it was for the purpose of exploiting the Highland Boy as a gold mine. He organized a company and built a big leaching mill on the ground and then, to his dismay, discovered that, on account of the copper in the ore, whatever gold the rock contained could not be recovered at a profit. That was his first intimation that Bingham contained any copper ore and he undoubtedly would have concealed the fact if he could; and he did as long as possible. Mr. Newhouse's familiarity with the commercial handling of copper ores is described in another article in this impression of Mines and Methods.

Inside and Outside of Alaska Gold Mines Deal

We are indebted to the Boston News Bureau of the tenth instant for a statement which seems to shed some light on the inside, as well as the outside, manipulations of the shares of the Alaska Gold Mines Company.

It will be remembered that, in August of last year, a circular letter was sent out by Hayden, Stone & Company to its large clientele of investors and the public to the effect that:

> There will be issued at the present time 614,700 shares and the company will hold in its treasury $1,790,000 Alaska Gastineau bonds out of a total issue of $3,500,000, being a majority, and $9,801,000, par value, Alaska Gastineau Mining Company stock, being about eighty per cent of the total capital of $12,000,000. There will be placed in the treasury of the Alaska Gastineau Company $1,250,000, and, in addition, in the treasury of the Alaska Gold Mines Company (the holding company) the further sum of $3,250,000, or a total of $4,500,000 in all.
>
> The balance of the authorized capital of 750,000 shares of the Alaska Gold Mines Company unissued, amounting to 134,300 shares, will be reserved for the general purpose of the company and to acquire, if it can be done on reasonable terms, the outstanding $1,710,000 of bonds of the Alaska Gastineau Mining Company, and the $2,199,000 of the capital stock of the Alaska Gastineau Mining Company.

Pursuant to the foregoing it was announced that the books would be opened for the receipt of subscriptions for the shares to August 28th. Thereupon, subscriptions were showered upon the promoters in such number that within a few days it was announced that subscriptions had exceeded the possible number of shares to be issued ten times over. Whereupon the manipulators of the market began with feverish energy by offering for sale subscription rights, the purchase of which involved the payment of the subscription price and then a premium which these rights were made to appear to bring in the market. By this process before the date for closing the books against subscription had arrived the price had been washed up to $9.25 per share; that is, the purchaser was required to pay $4.25 as a premium for the right to buy the shares at the initial subscription price of $5.00, to which, of course, would be added in due time $5.00 to complete the purchase

Upon the close of the subscription on the date stated, it appears that the issue had not only been over-subscribed ten times, but also had been oversold to like extent, and bought back in the process of washing up by the insiders at the advanced price.

Of course, it was expected that the public would come in and participate in the purchase of rights at the inflated price, and thus not only afford the original subscribers the usual and expected profits and quick returns, but also, for the holdings of the insiders which, as stated in a circular letter constituted "a large majority of the entire capital stock." But the public failed to respond and the consternation that ensued among those festive promoters was intense; in fact, indescribable. But they were equal to the emergency, and it was therefore announced broadcast that the confusion created by the excessive over-subscription had rendered an equable distribution of shares impossible.

At first dire threats were sent out that parties who had sold "short;" that is, those who had sold their subscription rights back to the promoters, were informed that they would be called upon at once to make delivery, and not being in position to enforce the issue of the shares to themselves of course a great number of wealthy gentlemen with speculative proclivities would be "put in a hole." But, upon further deliberation, the fact apparently dawned upon the avengers that they had prepared a very deep cavern between themselves and the would be legitimate vendors of shares which had been bargained to them and which they now proposed to refuse to deliver Thereupon the whole deal was declared off and the subscription list metaphorically burned.

After a week or more of apparent deliberation, and without previous notice to the public, offerings of the shares upon which it was purported $5 had been paid was inaugurated upon the market. Having denied all subscribers the right to shares under the subscription as before indicated it is difficult to understand just how those share offerings became part paid.

We have seen how that, as set forth in the Hayden, Stone & Co., circular, a large majority of the stock had been alloted to the group of gentlemen who constitute the board of directors, and who had already acquired the properties, which necessarily implies that these shares were thereby fully paid; so that, the remainder, whatever that may have been, and which had been offered to the public and later withdrawn as before stated, was alone subject to sale under conditions originally set forth. Now, as to whether the shares that were originally offered to the public were sufficient in number to produce $4,500,000, the amount agreed to have been placed in the treasuries of the two companies, will depend the question as to whether the majority holders would be required to contribute any amount in cash at all to make up an existing deficit The Boston News Bureau says:

> The Boston Stock Exchange has admitted to quotation on the unlisted sheet 193,279 full paid shares, and stock receipts for 517,295 half paid shares of the Alaska Gold Mines Co.
>
> The authorized capital stock is 750,000 shares. There are 39,426 shares held under option at par until July 1, 1913.
>
> The company owns $3,184,000 of a total of authorized issue of $3,500,000 first mortgage bonds and $10,095,140 out of a total authorized issue of $12,000,000 capital stock of the Alaska Gastineau Co.

From which it will be seen that the 135,300 shares which were "reserved" for general purposes of the company and to take up certain outstanding interests, etc., have been returned, which implies that no further interests are to be acquired.

This places the Alaska Gold Mines Company in possession of approximately five-sixths of the capital stock of the Alaska Gastineau Company, upon which interest the entire capital stock of the Alaska Gold Mines Company is based.

Now it appears that 193,279 shares have been alloted as fully paid stock to the gentlemen who compose the directorate and hold a large control as above indicated. This conclusion necessarily follows from the fact that no suggestion appears anywhere of any of the shares having been otherwise fully paid in cash. In addition to the allotment it appears that 517,295 half-paid shares have been disposed of to somebody—presumably the public—by payment in cash of one-half the par value, or $5 per share, leaving of the entire issue only 39,426 shares undisposed of, but which latter have been optioned to some favored interest. From all of which it will be seen that something more than 200,000 of the half-paid shares which would be necessary, including the fully paid allotment, to constitute a large control are evidently the property of the directorate; so that, assuming a final disposition of these shares by the payment of the balance of $5 the directorate will then own, without apparent cost, 193,279 shares, or a little less than two-sevenths of the stock of the corporation Therefore it is apparent that the directorate will be entitled to take down in cash all sums received for the remainder of their original holdings which may be in excess of $4,500,000, the amount which it is understood they will be required to place in the treasuries of the two companies. Thus it will be seen that the 517,295 shares fully paid stock will return $672,950 in excess of the treasury requirements. This sum, together with the value of the 193,279 fully paid shares if sold only at par will afford the very comfortable profit of $2,605,740.

Now, if we could assume that the activity in Alaska Gold Mines shares, whereby half-paid shares were carried up to about $16. in price, represented actual transactions in the stock, perhaps a couple of millions more profit might be added to the sum above mentioned. And yet, we are told, the deal is only in its infancy.

Possibly it might be assumed that the fully paid shares represented corresponding cash investments in the acquirement of the five-sixths interest in the title to the property which now seems to be lodged in the Alaska Gold Mines Company. But that would be a mistake, because it was stated at the outset that the sum of $4,500,000 which was to be derived from the sale of capital stock was to be applied "to the purchase of a control in the Alaska Gastineau Mining Company, and to construct a mill and finance the development of the property." Some indication of the price to be paid for the control may, however, reasonably be inferred from the fact that $1,250,000 of the gross fund is to be placed in the treasury of the Alaska Gastineau Mining Co., presumably for the benefit of the vendors.

Of course, the 39,426 shares optioned as before stated, whether sold or unsold, become naturally an increment of the profit of the gentlemen who hold large control as before indicated.

From the foregoing it is quite evident that when each of the participants becomes possessed of his share of the profits thus far accumulated it will not be long till the new issue of stock, frequently alluded to by the promoters, and which it is said would not be put out at less than $25 per share, will soon become a reality.

Therefore, it seems pertinent to observe in conclusion that the reputed withdrawal of stock from sale to original subscribers became operative to nine-tenths of the subscribers who were excluded, the remaining favored one-tenth being selected from the mass of subscribers with a view to their amenability to requirements which prohibited them from dealing in rights thus secured until full payment of the price had been made; and even then until the price could be washed up to a point at which the shares would become most attractive to the public—which, of course, is always the top notch.

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UTAH COPPER'S ANNUAL REPORT

The issuance on April 26th, 1913, of the Utah Copper Company's annual report to stockholders for the year ended December 31st, 1912, was not significant of any change for the better in point of actually enlightening stockholders as to the financial and physical condition of the company's affairs To the contrary, a review of the report elicits the information that, if anything, the deceptive practice of withholding facts which should be known to investors in the company's securities is, relatively to all preceding reports, more pronounced.

Brief outlines of the company's operations for the year are presented by the president and the general manager respectively; also, the usual series of statements (termed "Exhibits" in the report), purporting to clearly portray operating conditions at the properties in detail. While in the reports mentioned there seems to be, to the cursory reader, an apparent effort on the part of the management to present facts, yet such a condition actually does not obtain. Briefly, too much space is taken up in statements relative to ore tonnages developed at the mines; low operating costs at both mines and mills, resulting in a low production cost per pound copper that absolutely is incorrect, and other similar statements, all of which when subjected to analysis fail of substantiation.

In reference to the increase in developed ore reserves for the year ended December 31, 1912, the management has changed its method of computing available ore reserves over that obtaining during the previous year. For example, in the 1911 annual report an attempt was made to classify ore reserves according to the percentage copper content of the different areas of fully or partially developed territory, at least giving a semblance to the presentation of facts. The 1912 report is wholly different in that respect

Taking the matter up in detail it is observed that on January 1, 1912, the company claimed ore developed as follows:

FULLY DEVELOPED.

62,340,000	tons averaging	2.0%	Copper.
92,130,000	"	1.6%	"
75,660,000	"	1.3%	"

229,830,000 tons averaging 1.609% Copper.

PARTIALLY DEVELOPED.

71,670,000 tons averaging 1.28% Copper.

Combining the fully and partially developed ore reserves claimed, there is returned 301,500,000 tons of ore having a general average copper content of 1.532 per cent.

The manner of presenting the statement of developed ore reserves as of January 1st., 1913, is not so clearly defined in the report for obvious reasons, but is given as follows from the president's and general manager's reports:

Fully Developed Ore: 257,584,500 tons averaging 1.60% Copper.

Partially Developed Ore: 80,116,342 tons averaging 1.16% Copper.

The combined tonnages of fully and partially developed ore as stated return a total of 337,700,842 tons averaging 1.495 per cent copper, according to the management's report. Now in this connection the point to which attention is called is the fact that the total claimed tonnage, (337,700,842 tons of ore) represents the quantity of material developed since the commencement of development operations several years since. Then to determine the net tonnage remaining in the property as of January 1st., 1913, there is deducted from the total amount above given 21,200,842 tons of ore averaging 1.542 per cent copper representing the total tonnage of ore removed from the properties since beginning actual mining operations several years since. In that manner the quantity of ore reserves is reduced to 316,500,000 tons having a general average copper tenor of 1.495 per cent, representing the total available ore as of January 1st., 1913, a net increase in ore reserves over the year ended January 1st., 1912, of 15,000,000 tons.

The principal object sought in the presentation of the 15,000,000 tons of additional ore developed during the year 1912 in the manner mentioned seems to have been to evade a statement sufficiently direct to enable stockholders to understand the real value of the newly developed ore reserves. It may be of interest, therefore, to point out just why there was no distribution of ore tonnages made according to relative percentage copper content as in the instance of the 1911 report.

Assuming the correctness of the management's figures on ore reserves developed as of December 31st., 1911 and 1912, respectively, as 301,500,000 tons and 316,500,000 tons, then we may carry the matter a point further. During the year 1912 there was mined and milled on the properties 5,315,321 tons of ore averaging 1.3642 per cent copper. Therefore the actual gross increase in developed ore reserves developed during the year must have been 20,315,321 tons. Hence, if we make a strict comparison of the figures given it will be seen that the average copper tenor of the gross tonnage developed during the year, (20,315,321 tons), is 0.9271 per cent. It follows then that, allowing a deduction of 5,315,321 tons averaging 1.3642 per cent copper ore mined and milled during the year, the copper content of the net increased developed ore, (15,000,000 tons), contains an average of but 0.772 per cent copper—material that can not be consistently classed as commercial ore at the Utah Copper properties under the peculiar operating conditions obtaining thereon. Further, the addition of the net 15,000,000 tons of developed ore added to stock during 1912 has served to reduce the general average grade of the ore deposit from an average of 1.532 per cent copper for the 301,500,000 tons available January 1st., 1912, to an average of 1.495 per cent copper for the 316,500,000 tons available as of January 1st, 1913. The effect that this reduction in general average grade of developed ore will have on future operations is best reflected in the comparison of the grade of ore milled during 1911 with that milled during 1912—1.51 per cent and 1.3642 per cent, respectively.

Referring to the matter of stripping operations for the year it is noted that according to the management's statement the general average thickness of capping over the entire developed orebody has been increased from 106 feet in 1911 to 110 feet in 1912. According to the management's figures the area stripped during 1912 amounted to 11.909 acres, thereby bringing the total area completely stripped and available for steam shovel mining up to 44.529 acres. The quantity of material (capping) removed to December 31st, 1912, amounted to 17,289,725 cubic yards, equivalent to 35,910,767 tons; therefore, the actual average capping removed from the stripper area amounted to 240.7 feet in place of 110 feet, as stated by the management.

As previously stated the total tonnage of ore mined and milled, according to the company's report for 1912, was 5,351,321 tons of a general average grade of 1.3642 per cent copper. The mill production of copper in concentrates amounted to 96,175,090 pounds, equivalent to a saving of 66.32 per cent of the copper content of the ores treated, compared to a saving of 69.53 per cent during the previous year. The general average grade of concentrate produced was 20.75% copper, compared to an average of 25.62% copper for the year previously.

In connection with the cost of copper production we note that it is given at 9.024 cents per pound as compared to a cost of 7.8655 cents for the previous year, although in reference to the average mining and milling costs for the year it is noted that a decrease of 4.86 cents per ton of ore handled obtained over the cost for the preceding year. The cost of mining is given at 42.33 cents per ton ore; milling cost as 41.58 cents, and transportation cost on ore from the mines to the mills at 28.48 cents, a total of $1.1239 per ton. Smelting, refining and freight amounted to 83.422 cents per ton of ore mined. Taking these factors for the purpose of calculating the absolute direct cost of production it will be noted that:

Costs.

Mining and milling 5,315,321 tons at 83.91 cents	$ 4,460,085.85
Freight from mines to mill at 28.48 cents	1,513,803.42
Smelting, refining and freight, at 83.422 cents	4,424,175.34
Selling commission	154,073.34
Total	$10,552,137.95
Stripping orebody during year, 9,713,233 tons at minimum of 26.35 cents a ton	2,559,436.90
Total	$13,111,574.85

Revenue.

91,366,337 lbs. copper at 15.8391 cents	14,471,575.62
34,255.765 ozs. gold at $20.00	685,115.30
311,391.520 ozs. silver at 60.657 cents	188,880.07
Miscellaneous	382.33
Total	$15,345,953.32

Therefore, on the net production of refined copper the direct cost per pound, exclusive of stripping expense for the year only, or allowance of gold and silver credits, amounted to 11.55 cents. Allowing gold and silver credits the cost would be 10.59 cents, and by including the stripping expense for the year (as should be done) the cost per pound copper would be increased to 14.35 cents. It is plain that, even allowing the deferred payment of stripping expense as employed by the management under its system of accounting, the Utah company's production cost of copper does not fall under 10.59 cents per pound even under the most satisfactory operating conditions, and it is pertinent to observe that in view of the lower copper tenor of the ore now available for mining and milling the future production cost will be increased realtively to the 1912 figure rather than decreased as stated by the management

JACKLING'S VIEWS ON LEAD

When ex-Manager D. C. Jackling, of the Utah Copper and other companies, returned from his resignation trip to New York early in the month he was interviewed by a trusted and most competent reporter of the Salt Lake Tribune. Among the wise and otherwise things he was credited with saying was this:

"The lead and zinc industries are by some regarded with apprehension on account of the attitude of the present administration toward the tariff, but the taking off of the tariff is not going to kill or seriously cripple those industries. They are too big."

Mr. Jackling probably did not realize just how that was going to look in print; he did not seem to appreciate that such a statement might be construed as a direct slap at his friends and co-laborers, the Guggenheims. After reading it he most naturally grasped the situation and proceeded to make amends as best he could by being re-interviewed by the Herald-Republican the following morning, and the fact that the Tribune carried no correction of his statement indicates that the reporter for that paper did not misquote him. Here is the way he excused himself after having read what he said to the Tribune:

"There are very few producers of lead and zinc in the United States who could survive a complete removal of the tariff on these metals and such action would be little less than a calamity. Practically the only producers of these metals who would be able to survive would be those whose properties produce precious metals in such quantities as mean the difference between operation at a profit or at a loss. What I intended to have understood in my former statement was that I was hopeful that the final modification of the tariff would be so slight that, although it would surely be disturbing, it eventually would not interfere seriously with the mining industry of the country."

While the latter statement takes a little of the bad taste out of the first one made—or may ease him down with the Guggenheims—it is evident that the gentleman was worried over both statements, the one on account of what he did say and the other for lack of words with which to properly excuse himself.

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DEFICIT CONVERTED INTO PROFIT

According to the Utah Copper Company's first quarterly report for 1913, just issued, gross copper production was 23,884,467 pounds recovered from the treatment of 1,460,707 tons of ore having a general average copper content of 1.2495 per cent, reflecting an apparent mill extraction of 65.75 per cent.

It is noted that the general average grade of the ore treated during the first quarter of the present year is slightly higher in average copper content than was the material treated in the last quarter of 1912, which latter was 1.104 per cent per ton. However, considering the statements made by the management that there is fully developed and available for steam shovel mining some forty million tons of ore averaging in excess of 1.5 per cent copper, it is difficult to conceive why, in view of the policy of the company to treat its higher grade ores first, the grade of ore for the first quarter of this year is so low—and particularly in view of the fact that the entire developed ore reserves as of January 1st., (316,500,000 tons) were calculated to average 1.495 per cent copper. Weather conditions should by no means influence the metallic content of the ore reserves, and if the statements of the management are to be credited, the area of stripped ground available for steam shovel mining should contain ore of much higher general average copper content than has obtained during the past several months.

The report states further that "net profits for milling operations for the quarter were $1,110,346.21; other income, rents, etc., in Utah, $49,828.81, and income from Nevada Con. dividends $375,187.51, making a total of $1,535,362.53. Exclusive of the income from the Nevada Con., the direct income would be $1,160,175.02, thereby occasioning a direct deficit for the quarter of $26,452.48—no mention of which is made by the management. However, in order that the report might appear correct, the production cost of copper is stated at 10.175 cents per pound and the earnings are computed on a sales basis for the copper of 15.069 cents.

Considering the operations from a more logical point of view, and one more readily understood by the general public, it appears that (and the management's figures for the preceding quarter are used exclusively in the absence of the figures for the quarter in question, which will doubtless show an increase relatively to those for last year), on the gross copper porduction of 23,884,467 pounds of copper from the 1,460,707 tons of ore treated during the quarter in question; the basis of operating cost per ton being,—mining and milling 83.91 cents; freight from mines 28.48 cents; smelting, refining, and bullion freight 83.422 cents, and selling commission 2.88 cents, the total cost of treatment per ton of ore would be—exclusive of stripping expense or credits for gold or silver—$2,906,806.93, equivalent to $1.99 per ton. On the GROSS production of copper the cost per pound would, therefore, amount to 12.17 cents per pound. Then, assuming the sales price on copper to have been 15.07 cents per pound, the net profit on the GROSS production would be $692,649.55 for the quarter. Deducting this amount from the dividends paid, $1,186,627.50, a direct deficit of $493,977.95 will be apparent. However, allowing a credit of 0.957 cents per pound copper produced on account of credits for gold and silver there will be a reduction occasioned thereby amounting to $228,574.35, which, deducted from the original calculated deficit given above, would leave a net deficit of $265,403.60 for the quarter. Should we add to this the direct cost of stripping operations for the quarter (using the factor of 26.35 cents per ton as the minimum cost per ton of stripping 822,246 cu. yds. removed during the period mentioned), the direct deficit for the quarter would be $715,775.49—or approximately seven-elevenths the amount which the company claims to have earned as direct income from actual operation.

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WALKER AND RAY CON.

George L. Walker, editor of the Boston Commercial—and who should be classed as "associate managing editor" of the Utah Copper, Ray and Chino companies—has been making an inspection, or claims to have been making an inspection of the Ray Consolidated. It is impossible to take seriously anything that Walker says about anything, so it is hard to believe, in this instance, that he has been within 1000 miles of Ray. If he has, his findings appear all the more ridiculous. As an illustration listen to this:

> I took pains to investigate the various criticisms of Ray's operating practice that have been made by alleged experts. One of these is that in reconcentrating the concentrates, which is done for the purpose of eliminating additional silica and thus reducing the cost of smelting, considerable copper is lost. As a matter of fact, every drop of water and all the tailings from this operation are carried back and passed again through the mill with the ore, so that no possible loss can result. This criticism is on a par with the others, it is made by men who have not informed themselves.

Granting, for the sake of argument—the kind of argument that Walker likes to palm off on the public—that the Ray Consolidated is running its mill at a capacity of 6500 tons per day, and granting that in the first operation 400 tons of concentrates are produced, we then have 6100 tons of tailings to be returned (according to Walker's statement) to the top of the mill and mixed with new ore. As the mill is able to handle only 6500 tons in twenty-four hours, it follows that after 400 tons of new ore have been

added to the returned tailings, the mill's full charge of 6500 tons has been provided. Continued from day to day it would require about fifteen days by this process to rid the plant of the first 6100 tons of returned tailings and after the first day's operation there never would be room for more than 400 tons of new ore charge. Maybe the plant now is being run that way; we don't pretend to know. If it is, it is certain that the regular grade of mill ore is not being supplied to fill up the total tonnage treated. They must be utilizing the best grade of ore obtainable from the Ray Central, otherwise the claimed amount of copper produced would not be forthcoming.

However, while it is generally believed that the practice at Ray is indefensibly bad, no one charges that it is as bad as Walker would make it out to be.

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BUTTE AND SUPERIOR MAKES AWFUL SHOWING

A synopsis of the first annual report of the Butte & Superior Copper Company has been received by telegraph, and in it President MacKelvie is made to say that the amount of ore fully and partially developed is 1,200,000 tons averaging 21.7 per cent zinc; and further, that "the ore blocked out, together with that indicated, is sufficient to supply the milling facilities at full capacity for not less than six years."

During the past several months numerous reports have been circulated by the company's management that the two mill sections, when placed in operation, will have a normal capacity of 1,200 tons of ore daily and that a recovery of 90 per cent of the zinc mineral content of the ores treated will be effected. Under these conditions, and on a tonnage treatment basis of 36,000 tons monthly, the time required to exhaust the entire ore reserves in the mine will only be 2.8 years.

Therefore, assuming a mill extraction of 90 per cent of the zinc mineral, and the production of a concentrate averaging 47 per cent zinc, theoretically the ratio of ore concentration will be as 2.4 to 1, thereby affording a production of 500,000 tons of zinc concentrate. Of course, the theoretical perfection will never be attained, but the figure serves a very useful part in the calculation of the value of the property as now developed, and according to the management's own figures.

Thus on a basis of production of 500,000 tons of concentrate containing 47 per cent zinc, and a normal zinc market obtaining, the value per ton of the product as indicated by previous operations will be $23.60—equivalent to a gross value of $9.83 per ton of ore in place in the mine. Deducting from the gross value of the ore in place the cost of mining, milling, and miscellaneous expense, the net profit (under the most advantageous operating conditions) will amount to approximately $3.83 cents per ton. It will be apparent then that, incident to the treatment of the 1,200,000 tons stated, profit to the amount of $4,596,000 will be—or rather should be—earned during the entire life of the property. Amortizing the issue of $3,500,000 stock, the net return at the expiration of 2.8 years will be approximately $1,096,000—equivalent to about 32 per cent on the original capital. The value of the $10 par value stock then will approximate $13.20 per share, or less than half its present inflated quotation.

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THE FATES AGAINST THEM

The slump in the shares of Butte & Superior company to about 26 has been one of the recent events of interest. The mine owned by this company is without doubt a good mine, which will eventually pay dividends, but according to the impartial and reliable accounts that come to us its exploitation has been sadly bungled. The bungling has been peculiarly unfortunate in that it has coincided with one of the periods of 7c. price for spelter, which occur only once in about ten years.—Engineering and Mining Journal, May 10.

The trouble with Butte and Superior's exploitation is not particularly different from the blundering, floundering campaigns that the same crowd of manipulators have conducted on several other propositions and in which results have proven just as disastrous to all concerned. Month after month during the high-priced days of spelter, the sponsors for Butte and Superior were constantly declaring they had the biggest zinc mine in the world. All other zinc fields in the world might become exhausted and still there would be limitless supplies available from this tremendous and easily worked deposit. Just as the great copper miners of the country had overlooked the record-shattering deposits of "porphyry copper," so had the lead and zinc miners failed to appreciate or grasp the opportunity that had been beckoning them for so many years from a point close to the portals of the great copper mines at Butte. The game was played to the limit and the promoters reaped a harvest. But the day of reckoning came. The users of spelter argued that if one-half of the tales concerning Butte and Superior were true that the time was close at hand when the price of the metal would break; so they waited for the drop. At the same time the truth began to leak out that the mine was nothing like it had been pictured and stockholders began to unload. The promoters tried to stem the tide that had set in and, with the aid of every friend they could muster and deceive into buying the shares on the decline, they began to clean up and "strengthen" the market. The result has been the absolute discrediting of the promoters and the financial wrecking of a large percentage of their close friends and market followers.

The spectacle is indeed a sorry one and disconsolate losers by the hundred are now bemoaning their fate and wondering at the barefaced perfidy of their erstwhile associates, friends and chums. Practically the same game, with like results, has been played in Utah Copper and the followers of Ray, Chino and Alaska Gold Mines are skating on even thinner ice than that which stood between them and disaster in the Butte and Superior fiasco.

We have seen these low-grade porphyry copper "magnates" expatiate on the tremendous worth of their mines and shares and we have heard them declare that, owing to the magnitude of their properties and the never-before-heard-of low figures at which they could produce copper metal, the owners of the deep mines of Butte and the Lake country would be put out of business; that it was going to be a case of "the survival of the fittest"—and that they were the "fittest." It is different now. A year or so ago they were going to swamp the world with copper; now they are "stalling" for time and hoping that something may happen that will yet save their precious necks. With the disintegration of these bands of marauders and their banishment to obscurity the legitimate miner will stand some show. Speed the day!

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"Managing Director" Jackling seems to be just as busy as "managing editor" of the various companies from which he resigned (?) as he was when he held down general managerial jobs said to have paid him better than $100,000 a year. One would think that his successor as general manager would now be permitted to do some of the talking, particularly as John Hays Hammond, as managing director of Utah Copper, never "butted in" when Jackling occupied the driver's seat.

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None of the eastern financial and brokerage publications seem to have discovered that D. C. Jackling, as general manager of the Utah Copper, Ray, Chino and Butte and Superior, has resigned. Is it because Mines and Methods "beat them to it?"

Problem Now Confronting Bingham Porphyry Operations

We present herewith a photographic reproduction of the workings of the Utah Copper Company's mines, as it appeared in the company's annual report for 1912, showing the "big pit" and a front view of all that portion of the hill on which steam shovels have been, and are now, being operated upon ore and capping. This view shows an exposure of the entire claimed productive area of the company's property on the west side of the canyon, including the ground of the original Boston Consolidated Company, and the more important group quietly obtained from Theodore Barnsdall some years ago and called the Payroll group.

Readers who have in their possession a similar photograph of this hill, published by Mines and Methods in June, 1910, will, by comparison herewith, perceive that practically all steam shovel operations upon ore and capping have been extended, and are now well beyond the Utah Copper Company's original west boundary, and within the territory embraced in the Boston and Barnsdall properties. It will also be seen that, as indicated by the depth to which the pit has been extended in ore, there remains above the bottom of the pit, and westerly from its westerly surface margin apparently a very large volume of ore within the original limits of the Utah possessions. But it is also apparent that any attempt to secure this ore at this time by extending the west wall of the big pit would at once, within a few feet, carry that wall up to a junction with the surface slope of the higher portion of the mountain, which has already been carved off to the highest degree of inclination at which the ground will stand. From which it is evident that, with the exception of what may be recovered from longitudinal extensions and greater depth of the big pit, all steam shovel ore for many years to come must be obtained by carrying the higher levels westerly into the Boston and Barnsdall ground.

In this connection it may be observed that all the earlier reports of the Utah Copper Company, which purported to show developed reserves of ores of the higher grade—as for instance, 60,000,000 tons of 2.0% ore, and some 92,000,000 tons of 1.6% ore—are located easterly from the westerly margin of the big pit, shown in the picture, and therefore not available for steam shovel mining, because the easterly margin of this pit already encroaches very closely upon the canyon stream and county wagon road; so that all such ores, if indeed they have any existence at all, must be recovered by some underground method of extraction. And, as it was never claimed by the original owners of the Boston that any portion of the thirty-five or forty million tons of ore said to be developed in that ground at the time of its absorption by the Utah company, was of a grade above 1.5% copper—which estimate has been found to be far too high—the constant depreciation of the copper tenor of the ore which has been experienced, as the works extended into the Boston and Barnsdall ground, and, as shown in the later reports of the Utah company, can readily be understood and appreciated. And then, when there is added to the volume of this lower grade mass at least 100,000,000 tons of almost barren capping, as has been previously shown in this journal—and conceded by the Utah Copper management—no one can be surprised that the entire mass of the ore being sent to the mills should show a copper tenor quivering upon the danger line, which can hardly be compensated by the assumed expansion of ore reserves.

Visitors, and especially engineers, who have witnessed the operations of the steam shovels in this great pit could not have failed to note the great disadvantage and excessive cost which attends the operation of the shovels employed in the extraction of the ores therefrom; and all have marvelled at this expensive operation being continued at all, in view of the enormous mountain of ore apparently available for cheap mining. Of course the operation of the shovels, as seen at the bottom of the pit, was in the highest degree spectacular and impressive, which went far to round out that feature of the general scheme. But the reason for such operations lies much deeper than any purpose to startle or impress the mind of the casual visitor.

INTERESTING EARLY HISTORY.

Before proceeding further in this regard, and in order that our readers may fully realize the problem with which the management is, and has been for several months past, confronted, it will be necessary to relate a bit of the earlier history which attended the inauguration of steam shovel mining upon the so-called Bingham porphyries. At the outset there was a very deep, though friendly, rivalry existing between Manager Jackling and Mr. Samuel Newhouse, manager of the Boston Consolidated, as to whom should lead the record in inaugurating the mining of these new-found ores on the stupendous scale which had been mapped out by each. Perhaps it was not the fault of these gentlemen that previous to that time neither had ever received any technical training in matters pertaining to the nature or formation of orebodies, nor any practical experience whatever in the actual mining or reduction of ores of any description, save, and except, on the part of Mr. Jackling who had considerable experience in the operation of roasting furnaces and had assisted in the manipulation of ores treated by the cyanide process at Mercur, this state. But whatever was lacking on the part of either in point of knowledge, and experience in the matters of this character, was made up in enthusiasm of each to outdo the other, and both to excel the world's record—at least in the magnitude of operations and spectacular effect.

Mr. Newhouse was first to instal and put in motion the steam shovels. Having in a remarkably brief space of time equipped the Boston hill with a full complement he proceeded to strip off the surface of what had previously, by underground exploration, been determined to be the richest portion of the Boston hill, and by the time the mill at Garfield—the erection of which began about the same time—had been completed in one of its sections, a large area of the surface capping had been stripped down so as to lay bare a vast tonnage of smiling ore. Then began the more serious task of shoveling up the precious substance and sending it to the mill

The mill had been planned and constructed by a skillful mechanical engineer whose selection of machinery adapted to the treatment of the ore was standard in kind and the best of its class. There was no so-called teething or trying out of the machines that composed the equipment of this mill, each part being signally well adapted to the duty required; so that, from the moment of starting, results, in point of capacity, were all that had been expected. The yield of copper at once arose to about 70 per cent of the content of the ore, and was

Picture Taken from Last Annual Report of Utah Copper Co., Illustrating Problem Now Confronting the Management.

later raised to as high as 75 per cent, and the concentrates were clean in respect to silicious content. Everybody was happy. Mr. Newhouse, whose portrait had theretofore been published in the daily papers with almost tiresome frequency, appeared again in all the papers on the day of the starting of the mill—this time with his hat on, for he was busy all the time.

It may be observed that previous to the inauguration of these operations Mr. Newhouse had closed the sale of his interests in a neighboring mine called the Highland Boy, for which he received a very comfortable sum—a little more than $4,000,000—thus giving him a start several months in advance of Manager Jackling in notoriety which comes only from liberal tips frequently extended to the mining editors of the local papers. Whereas, up to this time, Manager Jackling had only received casual mention, the campaign which was to make of him the greatest engineer in the world being then only in its inception

The accumulation of concentrates at the Boston mill soon enabled Mr. Newhouse to begin regular shipments to the Garfield smelter in compliance with a contract previously made, by which a basic charge of but $5 per ton was exacted for smelting. The contract also provided that the concentrates should contain 23 per cent, or 460 pounds, of copper per ton. The value of any deficiency in the copper contents of the concentrates so smelted was to be charged against the ore; that is to say, if the concentrate carried only 12 per cent copper instead of 23 per cent, as guaranteed, the shipper was to pay the smelter the value of the difference between 12 and 23 per cent. Now, Mr. Newhouse not having had previous experience in dealing with smelters in the sale and treatment of ores, it had not occurred to him that the inclusion of iron, or any foreign substance into the ore, could become a matter of any consequence, or that the presence of such foreign substance, being of the same specific gravity of the copper minerals, might interfere and render impossible the production of concentrates containing 23 per cent copper. He knew he had a lower smelting charge by two dollars than Jackilng, and that was enough for him to know. At all events, the concentrates looked clean.

But, upon the arrival of the first shipment of concentrates at the smelter, scientific determination of the contents thereof developed the fact that there was contained but little more than 8 per cent copper; but in some manner, 35 per cent and more of iron had become mixed with the product. Even this was a most desirable compound for the smelter but as such would have commanded a smelting charge not exceeding $2.50 per ton; but, under the contract which required 23 per cent copper, upon settlement the mine would be required to pay over to the smelter a sum probably very much in excess of the total value of the resulting concentrates.

Of course, operations under these conditions could not be continued and the work of extraction would at once have to cease. The mill, however, cleaned up so much of the ore as had already been delivered at the bins and piled up the concentrates at the mill for future consideration. All further operations of the shovels, which had cost, up to this time, over $850,000, were suspended and the mine force was thereupon placed underground and began the extraction of ore from enriched channels which contained, at the same time, a low percentage of iron, and in this manner the mill was thereafter supplied with such ore and operated very successfully up to the time of its absorption by the Utah Copper company.

Later extensive exploration of the great mass of mineralized rock of which the Boston hill is composed, outside of the fissures, showed persistent presence of iron in combination with copper to the extent of 4 per cent and more, which, as before indicated, would produce a concentrate containing 35% iron, and not more than 8 or 9 per cent copper, so that with this experience in view, the fact at once became apparent to Mr. Newhouse that, aside from the narrow channels before referred to, it would be impossible ever to operate the property profitably until the existing contracts expired, and as the contract was for a term of twenty years, Mr. Newhouse was not long in deciding to formulate some plan by which the property could be unloaded upon the Utah Copper company. And so it was done

And now the management of the Utah Copper Company, having practically exhausted all other supplies of ore available for cheap extraction, finds it necessary to concentrate all operations upon the work of extraction and treatment of the same orebodies that had proved so disastrous to the first hopes of Mr. Newhouse, and paradoxical though it may appear, the Utah company enters upon the treatment of this particular ore under a smelting contract which requires, under penalty, a greater proportion of iron in the concentrates than results from treatment; that is to say, more than 35 per cent iron. And yet, at the same time, because of this excessive iron, the company is being mulcted by the same smelter contract to the extent of about two cents a pound on all copper produced.

A brief explanation of the Utah company's smelting contract will make clear the predicament into which the company has drifted, and which must sooner or later result in the wreck or suspension of work on this particular ore, or a modification of the contract so as to make it conform to conditions enjoyed by others who may send ore to the smelter without a contract at all. The contract of the Utah Copper Company originally provided first, for a flat charge of $6 per ton, but it also provided that the concentrates should contain ten per cent iron in excess of the total contents of silica; that is to say, if the concentrates contain thirty per cent silica they must also contain forty per cent iron, otherwise the company must pay ten cents per unit for each unit of iron found to be deficient of these proportions; no requirement is made, however, respecting the percentage of copper contained in the concentrates

Now, it transpires that all that portion of the original Utah ground from which ores with which to supply the mills have heretofore been obtained, including the lower portion of the stope above the big pit, and all of the ground easterly of the canyon in which extensive underground operations have heretofore been conducted, and also the ores within and bordering along the big pit, were much higher in copper content than the ores of the Boston hill referred to, are very lean in iron, so that concentrates produced from this area, whilst containing an average of twenty-eight per cent copper and better, and some thirty-five per cent silica, contain a general average of less than ten per cent iron.

These facts had been determined by Wall and DeLamar by extensive practical working tests made upon ores taken from all parts of the property and concentrated in a small mill nearby equipped for the purpose. And although Mr. Jackling was in position, by reason of his employment at the DeLamar works at Mercur at the time, to have become familiar with the mineralogical characteristics of the ore and concentrates, he, like Mr. Newhouse, was not aware that the presence or absence of iron in an ore of this character, cut any figure at all; and hence he was concerned only in securing a low basic rate for smelting the copper out of the concentrates. But when returns began to come in of settlements for concentrates delivered at the smelter it was found that, while the copper contents averaged twenty-eight per cent and higher, the silica contained was thirty-six per cent and the iron only ten per cent, thus producing a deficit in the guaranteed iron content of the difference between ten per cent and thirty-

six per cent, to which must still be added ten per cent iron in order to make that element exceed the silica by the required amount. In other words, the iron content was short of contract requirements thirty-six per cent which, at ten cents per unit, gave the sum of $3.60 to be added to the smelting charge of $6, bringing the whole sum up to $9.60 per ton of concentrates. And, for some months thereafter, the product of the Copperton mill was settled for on this basis, the smelting charge varying from around $8.50 to $9.60, as before shown, the manager apparently not being aware of the existence of anything irregular or oppressive in the terms or operation of the contract.

But in course of time Manager Jackling became wise to the imposition as he then regarded it, and by the intervention of powerful outside interests, the smelting company was induced to modify the terms of the contract to the effect that the total charge for smelting ores should not exceed $7 per ton; and as it could never be less than $7, because of Jackling's iron deficiency guarantee, it has remained at that figure.

We now come to the little joker which is rapidly eating into the vitals of the Utah Copper Company's net profit surplus, which may be briefly illustrated as follows: The average copper contents of the concentrates produced from ores obtained on the original Utah side, as above indicated, has been about twenty-seven per cent, equally to 540 pounds of copper per ton of concentrates, for which the smelting charge is $7, being equal to about 1.3 cents per pound. Now, the ores of the Boston Con. hill, upon which Mr. Newhouse wrecked his little craft as before related, must, as we have seen, afford for years to come at least practically the entire supply required for the mills of the Utah company contains, treated alone, as we have seen, only about eight per cent copper and thirty-five per cent iron. By a judicious mixture, however, of Utah ores it appears that the company has been able to raise the copper content to about twelve per cent. A ton of such concentrates would contain 240 pounds of copper only, the charge for smelting which is $7, being equal to about 3 cents per pound copper, or about 1.7 cents per pound of copper in excess of the general cost of smelting the concentrates from the original Utah ores, which contained, as we have seen, about twenty-seven per cent copper and low iron. Thus it will be seen that the Utah company has had its cost of producing copper increased nearly one and three-quarters cents per pound, by reason of the presence of a proportion of iron which, under fair competition, and not bound by a contract, should have reduced the cost of production by at least two cents per pound.

To overcome this disadvantage by raising the copper contents of the concentrates, and relatively lowering the iron constituents, the Utah company has been compelled to inaugurate the spectacular and novel scheme of extending a spiral railroad into the earth as shown in the big pit, in order to secure the proper mixture without regard to cost. This pit has already reached a depth of 225 feet, and a length of something more than a thousand feet the widest place in the bottom of the pit being about 400 feet. It is therefore evident that but little more of the desired mixture can be hoped for from this source, and as the stopes on the east side of the canyon have long since been practically exhausted, it is certain that Manager Gemmel is up against the "real thing."

Verily, there are some things in the smelting business always on tap to tangle the feet of the unsophisticated "mining man."

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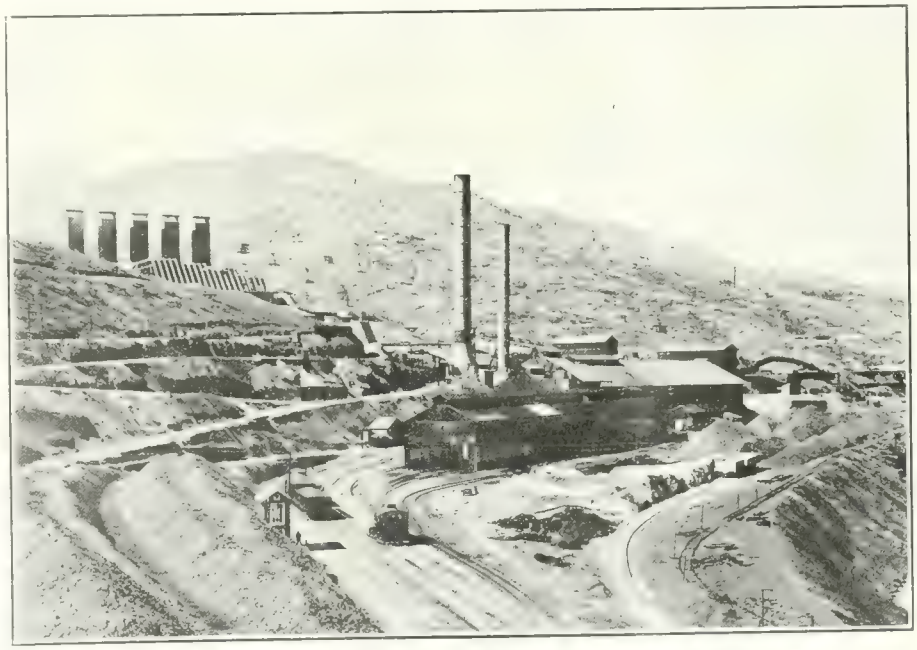
The annual report and the first quarterly report of the Chino Copper Company for this year are out, but we find no mention in either of them of how much it cost to pay the dividend on the shares issued to Parisians. It was probably an oversight. We respectfully call the attention of the management, the Boston News Bureau and George L. Walker to the matter.

Scheme for Control of Noxious Smelter Fumes

By AL H. MARTIN.

The control of smelter gases presents a problem of pressing importance to many copper producers. The generation of sulphuric and sulphurous acid gases by reduction of sulphide ores has stirred anti-smoke agitation in Montana, California, Utah and other states, and in some districts has forced total cessation of activities. As a result, prosperous towns have been suddenly ruined, and active districts virtually depopulated. The principal warfare against the smelters has been carried on by the agricultural interests, but in some instances civic bodies and the Federal Government have proceeded against the operators.

The campaign against the smelters has naturally stimulated efforts on the part of the operators to perfect methods for the elimination of the deadly fumes, but the problem presents so many complications that measures of effective control are exceedingly difficult to develop. The baghouse system seems to be the most satisfactory practical method for the control of the sulphuric acid gases, but even this device has failed to render entire satisfaction in all cases. The sulphurous acid gas is even more



Mammoth Smelter, Showing Bank of Cooling Flues and Baghouse

difficult of control than the first-named fume, and the methods at present in vogue for the reduction of its harmful agencies is by diluting it with many times its own volume of free air. This simply reduces the volume of gas escaping in a given time from the stack, and more widely scatters its harmful particles.

Most of the affected plants still operating are obliged by legal restrictions to reduce the sulphurous acid gas (SO_2) to less than 0.75% by volume as it passes into the atmosphere, while the sulphuric acid gas (SO_3), and all dust, must be completely eliminated. This ruling is based on the agreement between the Utah agricultural interests and the United States Smelting, Refining & Mining company, in the Midvale smelter case But while several plants operate under this compact, the charges are constantly made by the farmers that the law is not fully complied with in many instances—an assertion stoutly combated by the smelting interests.

The baghouse has proven the most practical system yet devised for the control of the sulphuric acid gases, provided these fumes are sufficiently neutralized by zinc oxides, hydrated lime, or other agents. But the contrivance is of little use for the treatment of sulphurous acid gas, which is a most destructive element, and has caused most of the friction between the operators and their antagonists. Consequently several attempts have been made to perfect devices that would satisfactorily deprive all the gases of their harmful properties. Thus far no practical method has been commercially applied, although one or two processes are showing promise under experimental conditions. SO_3 is a particularly active agent, and readily uniting with atmospheric moisture forms sulphuric acid, an element violently destructive to vegetation, fabrics and most metals, SO_2 while less active than the sulphuric acid gas, is generated in greater quantities, travels to great distances, possesses many harmful properties, and is particularly difficult to govern. The great quantities of solid matter escaping from the stacks in the form of dust have also given rise to many complaints, as it often carries arsenic and other poisonous substances, inimical to health and vegetation. The baghouse has proven encouragingly efficient in arresting the dust, in addition to its control of the sulphuric acid fumes, and its employment has facilitated the operation of smelters that otherwise would be unable to remain in commission.

BAGHOUSE OPERATIONS.

The baghouse is usually composed of from 2,000 to 4,000 bags, especially woven of pure wool for the purpose. While their size varies in different plants, many operators have adopted dimensions of 34 feet long by 18 inches wide. The bags are separated into sections, with about 100 bags to a division. Suspended vertically from a series of racks, the bags extend into hoppers, in which the dust and fume are shaken by mechanical agitation. The shaking device is attached to an electric motor, and at intervals the passage of the gases into the baghouse is intercepted and the loaded bags shaken into the hopper located directly beneath each section From the hopper the dust settles into a wooden trough containing water, from which it is drawn off into tanks and settled. The fumes coming from the blast furnaces and converters pass into the baghouse through a series of cooling pipes, to reduce the temperature of the gases, before coming in contact with the bags, otherwise the costly woolen bags, worth about $6 each, would be speedily consumed.

One of the most successful examples of the baghouse system is the plant of the Mammoth Copper comany, at Kennett, California, where the signal success of the device was the only means by which the company has been able to continue work in face of a determined opposition by the powerful farming interests. The fumes from the smelter are received at the base of the former stack by four pipes about 100 feet long and eight feet in diameter. These discharge into a flue 120 feet long by 15 feet square, through which the gases are drawn by two fans 11.5 feet in diameter and operating at 300 revolutions per minute. From this chamber the fumes pass into 45 cooling pipes four feet in diameter Sprays of water cool the pipes. The pipes discharge into a cooling chamber where the temperature of the gas is further reduced by blowing in cold air through the top of the flue which is 15 feet square and 220 feet long.

The gas travels through the 900 feet of cooling pipes at the rate of 2,700 feet per minute, and on its arrival at the bags its temperature has been reduced from 280 to 93 degrees C. The 2,960 bags are set 21 inches apart, center to center, and suspended vertically from the shaking racks. The gas enters the bags through their lower ends, under pressure of the blast from the fans, and after passing through escapes into the atmosphere by way of five square towers. This arrangement more widely scatters the volume of the escaping fume than would be the case if permitted to issue from a single outlet. The baghouse is open as much as possible to admit large quantities of free air to cut down the volume of SO_2 which is claimed to vary from 0.4 to 0.6% in volume. The company possesses a distinct advantage in its treatment of the SO_3 in the way that the ores carry a large amount of zinc sulphide which becomes zinc oxide in the blast furnace and unites with the sulphuric acid gas to form zinc sulphate.

To make absolutely certain that none of this gas escapes, about 30 pounds of hydrated lime are tossed into the fan blast every hour to neutralize any SO_3 escaping the action of the zinc. Approximately 333,000 cubic feet of gas passes the fans every 24 hours. The daily amount of free air consumed ranges from 20,000 to 25,000 cubic feet on cold winter days, to as much as 125,000 cubic feet in the summer season, as the volume of gas is reduced by cooling. It is claimed by the Mammoth people that the escaping smoke contains no sulphuric acid gas or dust, and that the volume of sulphurous acid gas ranges from 0.4 to 0.6%. Thus the escaping sulphur dioxide is asserted to be rendered harmless. It is interesting to note that in about two years of operation, the dust has yielded sufficient gold, silver, lead and zinc to more than cover total cost of the baghouse, but the management has been thus far unable to discover or develop a method whereby these metals can be profitably recovered from the material.

The baghouse at the Kennett smelter is illustrative of the system generally, and indicates the good uses to which it may be put, but it has nevertheless failed to control the objectionable sulphur dioxide, that invisible gas that has occasioned such trouble on the Shasta copper belt and in other fields. Consequently many investors are endeavoring to perfect a process that will completely subjugate this harmful element, and several promising methods are in course of development. An attempt to destroy the sulphuric acid and sulphurous acid fumes by an electrical current was made by the Balaklala Copper company about three years ago at a cost of approximately $160,000. The method, known as the Cottrell process, was given an extended trial and under experimental conditions promised much. But when applied on a commercial scale it proved impractical for the purpose intended. The process at times registered a maximum efficiency in excess of 96%, but at other instances fell far below this.

As a result the farmers proceeded to take active measures against the company, and after numerous experiments and endeavors to increase the efficiency of the process, the Balaklala directors closed down the big mines and plant, and have since made no effort to resume work. The proximity of this

smelter to the Kennett plant undoubtedly developed unsatisfactory conditions for both, as the volume of harmful gases in a limited atmospheric area was augmented considerably over what it would have been under other circumstances.

YOUNG'S THIOGEN PROCESS.

A method for the control of all elements of smelter fume that has attracted considerable interest is the Thiogen process, invented by Dr. S. W. Young, professor of physical chemistry at Leland Stanford university. The method is based on the well known laboratory experiments that when sulphurous fumes are united with oil-gas and passed over heated coke or limestone, containing iron salts, the structure of the sulphur dioxide is disintegrated and the sulphur precipitated. Several experiments with the process have been made at the Campo Seco smelter of the Penn. Chemical Company, at Campo Seco, Cal., but it is evident that many points remain to be decided before the method can be commercially applied. Experiments are still being made, and several highly encouraging tests have been conducted.

The fumes from the blast furnaces are driven into a combustion chamber where oil admitted from a spray has been vaporized by a temperature of about 800 deg. Centigrade by steam-injected burners. The volatilized crude oil releases carbon, an element necessary for the destruction of the gases. The combustion chamber is composed of brick checkerwork and the gases are thoroughly united with the carbon before passing to the reaction compartment. This is also formed of brick checkerwork, with the apertures nearly filled with a mixture of equal parts of sawdust and plaster-of-paris moistened with water and containing small quantities of iron salts. In the small spaces still remaining, lumps of calcium sulphide are placed. This forms a catalytic agent, naturally hastening the action of the carbon on the fumes. From this chamber the liberated sulphur passes in the form of vapor into the condensing chamber where it is cooled with jets of water and converted into the yellow product of commerce.

Calcium sulphide was selected as a catalyte because of its cheapness and general desirability as compared with a number of other substances that were given trial. It has been found desirable to thoroughly clean and concentrate the fumes before their admission to the combustion chamber, and under practical conditions an apparatus for this purpose is considered necessary.

Arsenic, selenium and other minerals are frequently associated with the sulphur in the composition of the fumes, and the presence of such substances in the precipitated sulphur would naturally unfit it for commercial usages. The best means of separation is during the period in which the minerals are in a volatilized state. For this purpose the vaporized fumes are passed through a broad, long, low, slightly-inclined condensing chamber, served with water sprays. The temperature of the gases is reduced sufficiently to precipitate the arsenic and other substances in the receptacles provided, while the more volatile sulphur passes on to the final condensing compartments. By the process, the structure of the SO_2 and SO_3 is said to be thoroughly disintegrated, and the smoke finally escaping is asserted to be practically free of all harmful properties. The gas is first passed through flues, to settle the dust, before being admitted to the combustion chamber, thus securing a clean product for treatment.

Numerous tests have been made with the process, and the greatest trouble appears to be the construction of a furnace wall that will resist the intense internal pressure. The furnaces at the Campo Seco smelter are of old design, and the leakage of walls has seriously handicapped experiments. Operating costs are also reported somewhat high, but the inventor believes that this expense can be materially lowered. It is pointed out that the recovery of the sulphur and other minerals in commercial form will largely compensate for fairly high operating costs, and the process is builded on the idea of turning the contents of the smelter fume to commercial account, in addition to depriving the gases of their objectionable properties. Further tests are being arranged for, and the fairly satisfactory results already obtained naturally commands respect for the method.

Prior to the conception of this process, metallurgists devoted scant attention to recovery of the valuable elements of the fume, and concentrated efforts on the development of a method for the control only of the sulphuric and sulphurous acid gases, content to accomplish this important point with slight consideration of the valuable sulphur and other substances going to waste.

THE NEW HESLEWOOD PROCESS.

Another process that is attracting considerable attention at this time, though still in an experimental stage, is the Heslewood process. This is a departure from the usual attempts to govern the fumes, and has given much promise at the few trials made. The process is based on an old principle, yet possesses many original features that makes it of particular interest to the mining world. The fumes are associated in the furnace with a small quantity of hydrogen gas, designed to break down the structure of the SO_2 with carbon subsequently employed to destroy the SO_3. The treated gases are then drawn by suction through condensing chambers into a reservoir of water, where the sulphur is precipitated and subsequently collected.

The small plant at which most of the tests have been made was erected at Heroult, Cal., by the Noble Electric Steel company. The furnace is an old one of the cupola type, formerly used by the Noble Electric company in smelting iron ores by electricity. With a diameter of five feet, it has an approximate capacity of 200 tons per 24 hours. The arrangement and operation of the furnace differs radically from ordinary practice. Instead of operating by forced draft, the furnace is worked by means of hydraulic suction, (this form of draft was employed by the ancients to some extent), and is said to have the advantage of reducing the volume of fumes, rendering their control correspondingly easier. The fumes pass from the furnace into a bustle-pipe, running around the furnace, which leads into a down-taking flue, terminating in an air-tight chamber. Into this chamber a centrifugal pump drives a jet of water under a 40.7 pounds pressure, which develops a powerful vacuum. This draws the heated fumes from the flue and the united force of the suction and stream of water carries the gases on through a condensing and agitating chamber, from which the sulphur and other minerals pass into the settling reservoirs.

In the experiments thus far conducted, ore carrying an exceptionally high percentage of sulphur has been smelted. The product was specially secured from the Iron Mountain mine of the Mountain Copper company, and averaged about 50 per cent sulphur. Such ore naturally generates an enormous volume of sulphuric and sulphurous acid gases, and the successful control of such an ore would make certain the control of a product containing a lesser amount of the objectionable mineral.

California crude oil was employed in place of coke for firing. Four burners were used and the petroleum introduced in the form of a spray. The oil generated an intense heat enabling the tapping of the furnace an hour after firing. As the smelting of the ore commenced, hydrogen gas was introduced to disassociate the oxygen from the sulphur, and facilitate the release of the latter from the other gases. From the furnace the fumes pass into the bustle-pipe and thence into the flue, where they are drawn through the carbon chamber. The vaporized carbon is obtained from red-hot coke, and by its use the structure of the SO_3 is further disintegrated and the SO_3 brought under control.

From this compartment the fumes continue to the condensing chamber and thence into an agitating compartment. The stream of water accompanying the gases from the condensing chamber enters the agitator under a pressure of 60 pounds per square inch and keeps the fume in violent circulation. The sweep of the water breaks up the bubbles of gas that would otherwise float on the surface of the tank, thus preventing any noticeable escape of fumes from this plant. From the agitating chamber the solution is carried into the settling pond. This is divided into compartments. The sulphur and other metallic substances settle to the bottom of one compartment, and when this receptacle is in use for a determined period, the solution is directed into a second compartment. By this means the sulphur can be cleaned up from the first compartment, and it is again ready for use. The smoke is then permitted to freely escape into the atmosphere from the surface of the water.

To guard against any escape of fumes from the agitating chamber, it is intended to place an air-tight hood over the compartment, and guide the elusive smoke into a small baghouse. This system has proven its value in recovering solids from the fumes, and with its union to the main plant, it is asserted every portion of the fume will be thoroughly treated, and all values extracted. An extensive system of dust chambers is also projected for a plant operating under practical conditions, as it is desired to have a comparatively clean fume before admitting it to the carbon chamber and following compartments. The use of hydrogen gas and volatilized carbon is stated to thoroughly break up the structure of the gases and render their effective control a matter of comparative ease.

The inventor states that the hydrogen is generated at small cost, and that its employment will not make the process a costly one, while it is probable that the carbon will be later generated from crude oil, as in the Thiogen process, instead of from coke, because of the lower cost. Tests have shown that the water used in the chambers and settling reservoir can be used over many times, provided the dust is largely extracted before the gases are admitted. Unless this is done the settlement of large quantities of dust in the settling ponds and chambers not only causes much annoyance, but also prevents the achievements of best results.

The employment of a suction draft in preference to usual smelting methods was adopted because of the less amount of oxygen consumed, and a corresponding reduction in the volume of the fumes. The inventor asserts that this method not only cuts down the volume of fumes four-fifths, but also increases the capacity of the furnace one-third. Such results with a single furnace, if borne out in actual practice, indicates the advantages accruing when several such units are operated in unison. It is further claimed that the powerful vacuum in conjunction with the intense heat resulting from the burning of crude oil, speedily clears the furnace of obstructions and prevents "freezing" even when zinc and other complex ores are being reduced. This claim is based on several tests with ores carrying a high zinc per cent.

In addition to the sulphurous and zinc ores, several tests have been made on iron-bearing ores from the mines of the Noble Electric company, with satisfactory results. It is essential that the furnaces be hermetically sealed when admitting the hydrogen into the charge, and that water jackets be provided for furnace and bustle-pipe. In the earlier experiments the intense heat from the furnace fired nearby woodwork, and seriously interferred with operations. Porous furnace walls have caused much annoyance; not only permitting the escape of heat, but also admitting large quantities of oxygen.

INVENTORS ARE HANDICAPPED

The inventor, J. A. Heslewood, has been experimenting with methods for the control of smelter fumes over a period of several years. The anti-smelter agitation has been particularly violent in California, and most of the smelters have been forced to close, or provide costly baghouses. Consequently the problem has attracted particular attention in this State. Before testing out his ideas at Heroult, Heslewood made numerous experiments with a minature plant at Oakland and Redding, and early became convinced that one of the chief points to be mastered was the reduction of the fumes to as small a volume as possible. With this end in view he adopted the hydraulic vacuum in preference to the ordinary forced draft. Early attempts to destroy the sulphur dioxide by bringing the fume in intimate contact with vaporized carbon and discharging the solution into water proved unsatisfactory in many ways, but the use of hydrogen indicated the advantage to be derived from employment of this gas. It was later found necessary to subject the solution from the condensing chamber to violent agitation, otherwise the gas bubbles floating on the surface of the water permitted important quantities of poisonous fumes to escape. The inventor has been constantly handicapped by lack of satisfactory apparatus, and has thus been forced to work under pronounced disadvantages.

So determined has the opposition of the California farmers been against the smelters, that permission to experiment with new methods has been denied, the grangers demanding that the companies conduct the tests in some sterile region remote from their plants. This has not only handicapped the copper companies in trying out new methods, but has also worked a decided hardship against inventors, as Heslewood, Young and others have learned.

While the Heslewood process was primarily designed to control the sulphur dioxide gases and facilitate the recovery of sulphur and other minerals from the fumes, it has been developed with a view to economical operation. It was early realized that the cost of treating the smoke and recovering metallic contents must be kept down, otherwise no company would feel justified in employing it, no matter how successful its mission might prove. The inventor claims that the erection of a plant along his designs will not exceed, and may not equal, the cost of an ordinary installation of like capacity, while the operating expense will be lower. Heslewood freely admits that there are several minor problems yet to be overcome, but insists that these are largely of a mechanical character, susceptible of certain satisfactory solution. The experiments made have been followed with much interest by operators on the Shasta copper belt, and it is certain that a thorough demonstration of the merit of the method under practical conditions will lead to its adoption by most of the companies now lying idle because of anti-smelter fume regulations.

There are several other methods undergoing tests in California, Montana and other States and some, apparently, present many points of interest. But it is the sad truth that many methods that work admirably under experimental circumstances, fail lamentably when applied to practical conditions. It has been suggested that the SO_2 be liquefied by ice or refrigerating machines, but the crucial objection is the absence of a market for the product, as the demand must be broad to take care of the enormous output that would attend such work.

The suggestion that the product could be used as a refrigerant has been met by the contention that the market is not only undeveloped, but also problematical, and that an immense expenditure of capital would be required for the development of a possible market, in addition to the heavy costs attending the installation of requisite machinery. Others have recommended the union of the objectionable fumes with slag, with subsequent treatment for recovery of metals, potash, green vitriol and other products from the compound.

THE ART OF MINING THE PUBLIC

Dishonesty of Men Responsible for Major Portion of Mining Losses—How the Guggenheims Thrive on the Use of Other People's Money

By SIDNEY NORMAN.

In the present demand for legislation tending to protect the innocent, if unwise and over-greedy, investor, an agitation that has already resulted in "Blue-sky" laws as variegated in operation as was Joseph's coat in color, the mining promoter has invariably been held up to the public as a shark without conscience, insatiable and altogether destitute of honest intention. The big operator, he who deals in millions filched from the pockets of the innocent, has been generally overlooked.

Though, unfortunately, there have been many sad experiences in the history of latter day mining, actual figures would doubtless show that the petty promoter has received but an infinitesimal tithe of the sums wrested from the savings stocking by the dishonest efforts of the real estate shark the stock exchange specialist, the irrigationist or the industrial fakir. Mining has one advantage at least and that in the fact that there is always hope, deep-hidden though it may be. No man can see farther into the earth than his neighbor and so the mining optimist cannot be proven a complete liar until handpower and drills have chipped their way to the points where his optimism lies walled up, in granite, or quartzite, or what-not.

EAST VS. WEST.

While a few have come out of the west with new brands of goods to cause sorrow to the innocent purchaser of mining shares, it is nevertheless a fact that the eastern promoter has been able, from time immemorial down to this day to give his western brother cards and spades in mining promotion rascality that tickles the dollar and the nickel from the widow, the orphan, the easy mark and the fool. This does not mean to insinuate that the eastern promoter is more dishonest than his confrere from the hither side of the Rockies, but it does mean that every trick of the trade is known within gunshot of Wall Street and that if the pilgrim wishes to "put over" a new one he is compelled to arise earlier than is fashionable in Gotham. The western man is an apt pupil sometimes, however, and when he has seen the shearing operation performed in artistic New York fashion he usually sends for his household goods and settles down to imitation that is something akin to sincere flattery and sometimes more cajoling than the original article.

Mining the public has its risks, of course especially in these days of investigations, but, so far as immediate results are concerned, it possesses allurements not apparent to the casual observer of real pick-and-shovel operations. Usually, real mining propositions, backed by the word of men of truth, directed by others who place honesty above the pleasures of get-rich-quick schemes have resulted in dividends and general satisfaction. The pity of it is that all losses are debited by the uninitiated to the mining industry and, as a consequence, the honest mining man finds it more and more difficult to secure capital for meritorious propositions as time goes on. Credit for success usually goes where the press agents of those identified with it direct. The mining industry itself rarely receives its due in public estimation.

"HIGHER UPS" RESPONSIBLE.

Those who are financially highest in the mining promotion firmament and who might, therefore, in all reason, be expected to do their utmost to provide protection for the investing public, have been primarily responsible for the contumely that is heaped upon the mining industry and that condition applies to New York as to no other place. In one case depreciation of no less than $20,000,000 in a few short years has resulted from the manipulations of one of the strongest corporations in the world, one that now has the effrontery to suggest public subscriptions to another $110,000,000 concern, this time in Chili, and of which it intends to retain nineteen parts and hand to the public three parts in return for all the money necessary to develop the ground.

The following history of the looting of Federal Mining & Smelting Company is a typical case and one that will tend to prove the contention that mining losses are more often occasioned by the rapacity of men than by the failure of the mines themselves. The details of the plan devised to deprive the public of its just due will show that the loss cannot be laid to the mining industry. The mines produce as they did when securities represented twenty million more good American dollars than they do today but profits have been, and still are, diverted through a secret syphon that carries them into the private pockets of those who occupy before the law the positions of trustees of the peoples' savings. It is to prevent just such dishonesty that additional criminal statutes are needed; in comparison to operations of some of New York's gilded brigands the speculations of the small promoter fall into insignificance.

THE COEUR d'ALENE DISTRICT.

The Coeur d'Alene district of Idaho is generally known as the most prolific lead-silver producer on the American continent and its contribution to the world's supply of lead has steadily risen since its discovery in the 80's. At the present time it produces practically one-half of the desilverized lead of the United States and close to 30 per cent of the domestic supply from all sources. In the earlier stages of its development dividends went into the pockets of local men, but gradually the extent of its earning power broke in upon the intellect of Wall Street and at this time a great number of its producing mines are owned by eastern stockholders.

Among those who early showed faith in the district was Frank Rockwood Moore, for many years one of the leading citizens of Spokane, Wash., who occupied the position of president of the First National Bank. He it was who developed the Emma and Last Chance properties at Wardner, and many thousands of dollars were supplied by him for that purpose. Then evil times fell upon the city and entire country and, following the great panic of 1893 the First National Bank was forced to close its doors, with a large portion of its assets tied up in the bonds of the Last Chance Mining Company. At that time the company was managed by Charles Sweeny, who commenced a romantic career at Virginia City, Nevada, and who in the past decade became a figure of prominence in the mining promotion world of New York.

CONCEIVED AND BORN IN DISHONESTY.

It would be idle to follow the course of events which, following the death of Mr. Moore, led up to the acquisition by Sweeny of the mining securities held by the bank but it is sufficient for these purposes to say that charges of dishonesty against the receiver of the bank became the subject of an inquiry by the Department of Justice in 1906.

Strangely enough, William Loeb, Jr., then secretary to President Roosevelt, now glorified "press agent" of the Guggenheims, is the man who notified the depositors of the First National Bank of the action of the Department of Justice, following an urgent demand of the President for a complete report. This merely shows the irony of a fate which now demands that Mr. Loeb confidential adviser of presidents, shall act as mixer of white-wash for some whose rascality he was partially advised of when he occupied an honorable position a few years ago.

Less than nine years after the failure of the First National Bank the interests in its possession had been gathered under the ownership of the Empire State-Idaho Mining Company, dividends had been paid, and Sweeny had moved upon New York for the purpose of merging that company into a larger concern, which subsequently assumed concrete shape as the Federal Mining & Smelting Company, listed on the New York Exchange in 1903, and now used as a football in its sacred precincts.

ROCKEFELLER AS PARTNER.

In those days Sweeny did not possess the breezy entree to New York banking houses later secured through his eminent qualifications but he was resourceful and forceful and early grasped the knowledge that the public purse would be opened wider to him could be but interest some financier of commanding position and use his name as a red herring across the scent of speculation. There was nothing small about him, nothing he would not dare to accomplish his ends, and so he decided upon John D. Rockefeller as his future partner, and to that end set his plans.

Prior to that time the Rockefeller interests had purchased the Monte Cristo mines near Everett, Washington, and, to provide reduction works for ore that never seemed to be forthcoming had built the Everett smelter at tidewater. Several years were consumed in proving the property worthless and it is said that the sum expended approximated $800,000. For some time prior to Sweeny's advent upon the scene the mines had remained idle and the investment appeared to be more or less a total loss

A REVEREND PROMOTER.

Sweeny laid his plans for the formation of Federal before Mr. Rockefeller's representative, in this case the Rev. Frederick T. Gates, and hinted that the proposition, rightly handled, provided a method by which the losses in the Monte Cristo mines could be shifted to the public. Whether or not the Standard Oil interests experienced any twinges of conscience is not set forth in the records available, but at least it is certain that the Monte Cristo mines and Everett smelter became a part of the assets of the Federal and the public was duly apprised of the fact that the greatest financial power in the world had considered the company's wares good enough to warrant a very large investment.

At the same time George J. Gould was duly "touted" as another of the big ones who could not resist the temptation to take on a little Federal stock but so far as known no mention was made of the fact that before his subscription was made it had been arranged that all shipments of ore from the company's mines should be routed to Colorado points over the Gould system of railroads at satisfactory rates.

To make the anaesthetic quite complete John D. Rockefeller, Jr., Rev. Frederick T. Gates, George J. Gould, E. Parmalee Prentice, son-in-law of Mr. Rockefeller, and George W. Young, the well-known Wall Street banker, were elected directors.

GUGGENHEIMS PANIC-STRICKEN.

The arrangements carried promise of serious portent to the hearts of the Guggenheim Brothers, however, then about completing plans for monopoly of the lead industry with the public's funds, and, so the story goes, long and earnest consultations resulted. At no time did the Federal seriously contemplate entering the smelting field but the old Everett smelter served the purpose for which it was intended and scared the Guggenheims into frenzied belief that the most powerful financial interests of the country were ready to jump on their backs and wrest control of the industry from them.

So overtures for peaceful settlement were made, with the eventual result that the Guggenheims secured a six-year contract for all Federal ores, at an attractive price and in part consideration therefor the sum of $600,000 was paid for the smelter and mines formerly owned by the Rockefeller interests, absolutely worthless as going concerns, but which had now served their purpose in catching the dollars and nickels of the innocent public. Federal, in its turn agreed not to enter the smelting business and everything was again lovely—except for the Guggenheims, who had been "stung" for $600,000 and very naturally were already plotting to recoup themselves from the depths of the public purse. It will not surprise the reader to learn that they did—most completely and thoroughly.

TRICKS OF THE TRADE.

Smelting and refining charges are more or less unintelligible to the general public, but it is necessary that the terms of the contract entered into in 1903 should be digested in order that subsequent events may be understood. Prices for lead are made in New York and St. Louis and are based upon lots of 50 tons for thirty day delivery. Incidentally, as the Guggenheims control the major portion of the lead output of the country, the price is made by them, as no dealer wants to sell for less than the trust quotation and it is obvious that he cannot sell for more.

It is claimed by the smelters that reduction of lead ore results in the loss of ten per cent of the values passed through the furnaces and, in consequence, while the loss is more theoretical than practical, all contracts are made for but ninety per cent of the lead contained in the ore. In other words, if a producer ships a ton of ore containing fifty per cent lead, it is evident that the shipment contains 1,000 pounds of pig lead. But he does not receive payment for that amount. Ten per cent is deducted for "smelting loss," and he receives payment, upon whatever financial basis has been arranged, for 900 pounds instead of 1,000. It is generally admitted that the practical loss in smelting is well covered by five per cent, so that on every ton of such ore the smelters "knock down" approximately fifty pounds of lead worth an average of about $2.10 in the past thirty years. Unimportant in small consignments, it can be readily understood how vitally this deduction influences the receipts of the smelting companies when applied to shipments that run into the hundreds of thousands of tons each year.

COURSE OF LEAD MARKET.

The average price of lead for twenty years prior to 1903, when the Federal-Guggenheim contract was made, had been around $4.00 per hundred pounds, while for the year 1902 the average had been $4.15. The contract, at that time reasonably fair to both sides, provided for settlement on a basis of ninety per cent of the lead in the ore, at ninety per cent of the price of lead in New York, so long as that price stood at $4.10 or less per hundred pounds. If the quotation advanced above that figure the producer and the smelting company were to divide equally the difference between $4.10 from the New York market quotation. Thus, if lead advanced to $4.50 say, the Federal

company received ninety per cent of $4.10 or $3.69, plus one-half of 40c, or a total of $3.89 for lead selling at $4.50 on the New York market. The smelting company took 61 cents per hundred pounds, in addition, of course, to the usual treatment charge, in this case $8 per ton.

Under this basis of settlement heavy shipments were made by the Federal and quotations began to show activity on the New York Stock Exchange. When the company was organized, with $10,000,000 seven per cent preferred cumulative stock and $5,000,000 common stock, part of the latter had been given away as a bonus with preferred. The common stock, however, carried all voting power, the preferred stockholders being allowed no voice in the management of the property or in fact on any question but the increase or decrease of the volume of their own security. After providing the common stock bonus the insiders retained direction of the company's affairs without having subscribed a dollar towards its financial equipment.

REV. GATES "PUTS ONE OVER."

In the early part of 1905 there was a decided uplift in the quotation of common stock, an advance that could hardly be attributed to improvement in the conditions at the mines. Rumor says that the Guggenheims had been jockeying for control, and that, forgetful of the strength and experience of other interests connected with the company, had "shorted" a large amount of the common stock in order to depress the market and make a larger amount available at lower figures. The game appeared to be working well until suddenly there was a decided shortage of certificates for delivery

It then dawned upon the Guggenheims that the Rockefeller interests, through the Very Reverend Frederick T. Gates had been quietly absorbing additional holdings and had generously loaned large numbers of certificates to facilitate deliveries. The long and the short of it was that the Guggenheims were ordered to step up and settle and, after pardonable squirming, they did. For common stock given away as a bonus about two years previously they were compelled to pay a fancy price(rumor says $120) and it is also said that nearly 20,000 shares changed hands. This represented some of the profit secured by the Rockefeller interests for a worthless smelter and more worthless mines that had been used as bait for the public and already sold once before to the Guggenheims for $600,000.

Rumor also says that the persuasive eloquence of the Reverend Mr. Gates included a threat that, unless his terms were accepted forthwith, the Standard Oil-Amalgamated Copper interests would immediately enter the lead-smelting field. It is also said that an agreement was entered eventually into by which the latter undertook not to enter that field for a period of five years. Color is lent to this report by the fact that just five years later the Standard-Amalgamated began preparations to reduce lead ores and a little over two years ago became an active competitor in the Coeur d'Alene and other fields through the International Smelting & Refining Company, which "blew in" its lead stack at Tooele, Utah, last year, after piling up nearly $4,000,000 worth of lead-silver ores. This is high finance with a vengeance but as it affected only interests financially powerful, the harm was not general.

ROCKEFELLER LOANS TWO MILLION DOLLARS.

The Guggenheims, however, now possessed about 28,000 shares of the 50,000 issued common stock of Federal, besides having been mulcted in the sum of $600,000 for the Everett smelter and Monte Cristo mines, for which they had no more use than a burglar has for daylight. Being short of funds when they accepted the generous terms of the Reverend Gates, they were compelled to borrow $2,000,000 from John D. Rockefeller himself, and had agreed to pay him back, with an entirely satisfactory rate of interest, in $500,000 payments. Annual notes of $1,000,000 had also been given to Federal in payment for the smelter and Monte Cristo mines, so that these particular days do not appear to have been good ones from the Guggenheim viewpoint and scouts were already abroad in the financial land to devise some method by which the strain could be relieved.

When these emissaries reported to their superiors in due time it was decided, in the first place, that the contract for the ores of Federal, now vital to the supremacy of the Guggenheims in the lead smelting industry, should be perpetuated for a long term of years to offset danger of Standard-Amalgamated competition. Accordingly in October, 1905, the "dummy" directors placed in control of the company's affairs by the Guggenheims, met in solemn conclave and "whereas it was the desire of Federal to sell and the desire of the Guggenheims to buy," a new contract, to take effect four years later and run for twenty-one years thereafter, was entered into and the output of Federal thus bottled up for a period of years that would in all human probability run beyond the productive life of the mines. It should be remembered that this was in 1905, that the original contract of 1903 still had four years to run and that the Guggenheims were really both contracting parties. At this time Federal was producing approximately twenty per cent of all the lead of the United States.

AN UNHOLY CONTRACT.

By the time the Guggenheims had secured control of Federal the price of lead had advanced materially on the New York market, the average for the two past years having been around $4.30 and the quotation on the day the second contract was signed in October, 1905, standing at $4.85. In spite of this advance and in spite of the fact that a shortage in the domestic lead supply seemed not improbable within comparatively few years, the second contract called for lead settlement at the same level as provided by the contract of 1903.

This meant a loss of eighty cents for every hundred pounds of lead in Federal ores, or approximately $6.17 upon every ton of crude ore or concentrates shipped to the smelters. Upon average yearly shipments running well over 100,000 tons it will be understood that the amount involved in one year was very considerable and in the twenty-one years covered by the contract simply stupendous.

Of course the contract also called for a treatment charge of $8 per ton and provided for a freight rate of $7.50 to Denver or Pueblo, the longest possible haul. The Guggenheim interests, however, maintain a lead smelter at East Helena, Mont., to which point ore can be transported at $2.75 per ton. What becomes of the difference between the long and short haul rates on carload lots diverted to Helena can be readily guessed.

If Federal shipments should be maintained at present levels for twenty-one years from 1909, and if the product should be sent to Helena instead of Denver or Pueblo, the Guggenheims will have received approximately $22,000,000 in excess of the $8 treatment charge provided in the contract, which would in itself reach the respectable total of almost $20,000,000.

Two or three possibilities might prevent the collection of this tremendous unjust tax upon mines developed by public funds. The mines might be exhausted before the contract expires; the price of lead might depreciate to such a figure that mining operations would be unprofitable, or the efforts of minority interests to annul the contract and recover the amount taken above a fair charge since 1909, will prevail in the courts. Otherwise an act of God will be necessary to break the Guggenheim strangle-hold. It is useless to appeal to their sense of justice and square dealing. That has been unsuccessfully tried.

A LITTLE EASY MONEY.

Having locked up from marauding hands and having provided for the return many times over of their outlay, the Guggenheims lightly turned their attention to making some quick, easy money by stock manipulation. The first step was to issue 20,000 additional shares of preferred and 10,000 shares of common, ostensibly to provide funds for the purchase of the Morning and You Like mines at Mullan, Idaho, from the late Peter Larsen and Thomas L. Greenough. It is said that the price paid for these properties was $3,000,000, but they passed through many hands before finally reaching Federal and it is perhaps safe to assume that some of the money stuck to somebody's fingers on the way.

This new issue was offered to stockholders already of record, but meanwhile "bear" stories were circulated about the company's mines and the demand was by no means brisk. A little inside syndicate took up the balance remaining after the demands of stockholders had been satisfied, thus providing the Guggenheims with enough stock, outside of sufficient to retain control, with which to make a little manipulation very attractive from a monetary standpoint.

Production was maintained at high pressure and, with advances in lead and silver to help the game along, quotations on preferred were hoisted to $112½ and on common to $199 in 1906, when dividends of 17% on common were distributed, besides full 7% upon preferred. In 1907 common dividends of 14½% were distributed, but the manipulative campaign was then about over and no dividend on common has since been paid, except one of 1½% early in 1909.

One of the remarkable features of the campaign is the fact that men of great prominence in the financial world, men who should have known better, were drawn into the net and to this day retain common stock holdings that have cost from $145 to $199 a share. Women, too, appear to have been victimized even more than usual. Last year's list of stockholders shows that there are no less than 980 women holding stock of both issues all the way up to the high point.

CONCEALING FACTS.

Meanwhile evidence of control of Federal by the Guggenheims had been zealously guarded from the general public, though the stock books show that at no time since July, 1905, have they owned less than a safe control of common stock in the name of the American Smelters Securities Company. When the latter was listed on the New York Stock Exchange in 1909 no official mention was made of the ownership and none has been made since.

In 1911 the financial press of New York hinted at the real ownership of control and in December of that year "M. Guggenheim's Sons" published an advertisement in the New York Times positively stating that they owned but "one-sixth" of the capital stock, acquired several years ago at private sale, and that they had never sold or traded in a share of that stock since. The advertisement was a cunningly worded subterfuge in that their holdings, while only one-sixth of all issued stock of both kinds, were in reality over one-half of the issued common stock, which alone carried administrative power. At no time had they owned any of the preferred issue.

One year later, in November, 1912, the same rumors of ownership arose and this time the Guggenheims sent out an official statement to the press containing the subject matter of the advertisement published the year before. By this time the suspicion had grown to a moral certainty, however, and but few financial editors in the city cared to assume responsibility for publication of the item.

A few weeks ago, when the matter of concealment of Federal control in listing American Smelters Securities Company was considered by the New York Stock Exchange as the result of charges made by minority interests, Edward Brush, vice-president of the company, stated that the Federal holdings were out of the hands of the Guggenheims for a few weeks or months about the time American Smelters Securities was listed. The books however, show no such transfer and it is evident either that this statement was a deliberate falsehood or that M. Guggenheim's Sons misled the public in their advertisement and subsequent official statement. There is no escape from such conclusion and it is illuminating as proof of the fact that downright deceit is no hindrance to consummation of some plans of high finance.

The manipulation of Federal to high levels and its consequent meteoric drop, occasioned by cessation of common dividends, doubtless resulted in an appreciable clean-up for the inside interests. This object having been attained, official "bear" stories were circulated concerning the early exhaustion of the mines and quotations receded to the present neglible level. Last year, presumably for the benefit of the Ways and Means Committee of the House of Representatives, which a few months later was called upon to consider the metal tariff schedule, dividends on preferred were dropped to 6% and have since remained at that figure. A surplus of $1,300,000 was accumulated in Federal's exchequer and that sum is now being used to perpetuate the Guggenheim hold upon the lead industry at the expense of Federal. It must be remembered that the twenty-one year contract provides that every property henceforth acquired by Federal must ship its product under its provisions.

A NEW TRUST "RICHMOND."

As agent in their campaign to acquire more properties for themselves, in the name of Federal, with Federal money, and of which all profit apart from preferred dividends was to accrue to their smelting pocket, the Guggenheims selected Harry L. Day, part owner of the Hercules mine, near Burke who was made president and general manager of Federal last summer at an annual salary of $15,000 and expenses. Day had been the most rabid assailant of the Guggenheims and their methods in former days and is a brother-in-law of Ed Boyce, former president of the Western Federation of Miners, now capitalistically inclined as a marriage-owner of Hercules, but in the earlier days known as one of the most dangerous agitators in the labor troubles that led up to the assassination of Governor Steunenberg by Harry Orchard.

In 1902, Day and his partners in an effort to circumvent the trust had purchased an interest in the Selby smelter at Vallejo Junction, California. Subsequently the Guggenheims acquired this interest for approximately $400,000 and secured a ten-year contract for Hercules ore at a lead settlement basis of flat New York quotations, less 60 cents per hundred pounds. This contract would have expired this year and it looked as if it might slip through the Guggenheim fingers into those of the International Smelting & Refining Co., which had recently entered the lead-smelting field To prevent this the Guggenheims voluntarily cancelled the contract last year, making a new one providing for lead settlement at flat New York quotations with freight and treatment rate of $14, using as a further lever sufficient flattery to induce Day to accept the position of president and general manager of Federal.

Since the latter assumed the reins of trust power properties have been purchased or contracted for to the tune of over $1,000,000 and it is rumored that several other big producers are being bargained for. Should such prove to be the case large additional sums would be needed to finance the undertakings and the Guggenheims will then be forced to go to the public with an additional issue of Federal stock, as, unless the new mines are acquired through Federal, it would be impossible to bring their product under the present twenty-one year contract.

MILLIONS IN PROFIT.

The importance of the output of Federal in its bearing upon the Guggenheim domination of the lead industry of the United tSates can best be understood by study of the following figures of production from 1906 to 1912:

Year	Tons Ore Shipped	Tons Lead	Federal per cent of U. S. Production
1906	130,855	63,029	18%
1907	130,373	59,746	16%
1908	 93,811	43,988	19%
1909	....122 764	56,904	15%
1910	107,826	48,155	12%
1911	118,315	50,875	12%
1912	118,734	50 936	12%
Total	..822 678	373,633	Av 7 yrs 15%

On total shipments of 822,678 tons crude ore and concentrates it is evident that the smelting trust has collected no less than $6,581,424 in treatment charges at $8 per ton. The average price of lead during the period was $4.71 per hundred pounds, while by the provisions of the present contract, Federal received but $3.99 per hundred pounds. This left an unjust profit of 72c per hundred pounds for the smelting trust, a sum equal to $5.25 per ton of ore and concentrates shipped, assuming that such shipments contained 40% lead during the entire term. With total shipments of 822,678 tons it will thus be seen that the Guggenheims have benefited to the extent of $4,319,062 above and beyond a fair price for treatment. Under a presumably fair treatment charge and an unjust tax of $5.25 per ton the total amount yielded to the Guggenheims in seven years was no less than $10,900,486. This is apart from any possible unfair profit derived from diversion of shipments from the long haul to the short haul point of reduction. If all shipments during the seven years had been sent to Helena instead of to Colorado points another clear profit of $3,907,720 would have resulted to the smelting company. Just how much of the product has been so diverted it is impossible to ascertain except through the Department of Justice or Interstate Commerce Commission. In all probability these facts will be available within a comparatively short time. Omitting this item entirely, however, it can readily be seen how valuable the output of the Federal is to the controlling interests. The ordinary man may also understand something of the methods by which the Guggenheims have built themselves up to the controlling factor in the lead industry of the United States.

MINORITY TAKES ACTION.

In the fall of 1912 a small coterie of stockholders decided to make a stand in their own behalf and in that of others similarly situated. The Guggenheims were approached with a friendly request to revise the contract in simple justice to those who had invested in good faith, but the emissaries were laughed at for their pains and so suit was started in the New York Supreme Court. The complaint sets forth the salient facts as above stated, asks for an annulment of the contract upon the allegation that it is fraudulent, an accounting for approximately $2,000,000 for sums wrongfully taken since the twenty-one year contract went into effect and an injunction prohibiting Federal from acquiring new mines to be operated under the present contract.

While every artifice will be used by the trust to prevent the matter coming to trial, the outcome will be watched with great interest as one of the most important mining cases filed in many years. The rights of minority interests have been clearly defined in a long list of widely-distributed decisions and those in charge of the fight firmly believe that this time the Guggenheims will be brought to time.

THE LESSON OF FEDERAL.

The lesson to be gleaned from these facts by the investing public is that the losses sustained by Federal stockholders are in no wise due to the failure of its mines to respond handsomely to development. In fact if Federal (which the Guggenheims control) were permitted to ship its product on the same lead settlement basis as is granted by the trust to the Hercules mine of President and General Manager Day (which they do not control), the present earnings would be at the rate of over $1,750,000 a year. This would provide full 7% on $12,000,000 preferred stock, 10% on $6,000,000 common stock and still leave a surplus of over $300,000 for contingencies. At present settlement rates its earnings are approximately $1,000,000 a year, of which $840,000 is due to preferred stockholders.

Unfortunately for the general good of the great mining industry, which adds two billion dollars a year to the wealth of the nation and employs many hundred thousands of men, the experience of Federal stockholders is used as an argument against the industry. It cannot justly be so construed and rather proves that mining, where properly and honestly conducted, offers returns that cannot be duplicated in other lines of endeavor. It should teach the investing public that the honesty of those in control is of as much importance as the value of the mines upon which their securities are based and that, in the absence of square dealing, innumerable methods may be devised to cheat them of the reward which is their rightful due.

Comparative Efficiencies in Use of Compressed Air

By G. A. DENNY.

I have been invited by the Council to contribute a paper to the Institute, which may serve as a type of the communication which the Council specially desires to obtain, namely, short papers dealing with subjects particularly adapted for discussion.

My aim in the following note will be, I believe, perfectly patent to my colleagues. No attempt is made to support by more than generalizations, the statements made, the object being to supply a skeleton around which useful and informing discussion may build a body of opinion and experience, which will be instructive to us all.

In choosing the subject of compressed air transmission, I have especially in mind, that it is one in which we are all interested, and all have more or less costly experience. Moreover it is a branch of our mechanical operations—invaluable and essential though it may be despite its deficiencies,—which offers an excellent target for the critic purposely seeking only its misdemeanours, in order to invite discussion in its defence.

In a similar spirit, but from an opposite standpoint, the benefits of hydraulic transmission are touched upon, with the intention of provoking critical discussion.

The problems of air compression and transmission are as numerous as they are complex. Pressure, temperature, and volume, have an interchangeability of relationship, which whilst fully covered by theoretical formulae, are most elusive in habit, and unsubmissive to theoretical demands in every day practice.

Our definitions of free air, generally apply to pressures of one atmosphere at sea level, or 14.7 lbs., and 60 deg.,

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temperature F. But what infinity of variation is there from those bases. Every latitude, every elevation, almost all specific localities, have their own peculiar involutions of volume, temperature and pressure, each new combination giving rise to relationships, singular to themselves. Absolute temperatures, must be considered in all cases, whether dealing with free or compressed air, as weight and pressure will vary in accordance with the absolute temperature of the original volume, the latter also suffering variations in conformity with the rise or fall of the absolute temperature. At 30 deg., or 491 deg. absolute, a cubic foot of dry air at sea level and average atmospheric pressure weighs .0811 of a lb., and the volume of 1 lb. at this temperature and pressure, is 12.336 cub ft. At 90 deg F.--absolute 551 deg.—a cubic foot weighs .0722 lbs., with a volume for 1 lb. of 13.853 cub ft. At 200 deg.,—absolute 651 deg.,—a cubic foot weighs .0602 lbs., with a volume of 16.907 cubic feet.

The relationships of temperature, pressure and volume have been succinctly stated as under:

1.—The absolute pressure of air, varies inversely as the volume. when the temperature is constant.

2.—The absolute pressure varies directly as the absolute temperature, when the volume is constant.

3.—The volume varies as the absolute temperature, when the pressure is constant.

4.—The product of the absolute pressure and the volume is proportional to the absolute temperature.

When air is compressed, an increase of temperature takes place but not proportionate to the pressure, nor will air which is taken into the cylinder at zero, have a temperature increment similar to air which is taken in at 100 deg. At two atmospheres gauge pressure, for instance, air of an initial temperature of zero, will have risen to 170 deg., whilst air of an initial temperature of 100 deg., will have risen at the same gauge pressure to 320 deg In the higher pressures, the rate of temperature increase is much lower. For instance, air of an initial temperature of 100 deg. will only rise about 20 deg. between gauge pressures of 21 and 23 atmospheres.

The importance of the question of original temperature of the free air, cannot be overestimated, since that volume of free air which we take into the cylinder, is in the last resort the unit we have to count upon for work. If the air is so heated at the moment compression begins, that its volume is increased by say 20 per cent, we are actually reducing the capacity of our machine—from a basis of cool air—to that degree, and have to exert as much power for the compression of an 80% cylinder charge, as would be required for an 100% charge of cooler air.

Even when every precaution has been taken to provide the coolest and cleanest supply of air available, to the compressor, we still have the heated condition of the air cylinder itself to contend against, which causes an immediate rise in the temperature of the entering air, reduces the volume, and deprives us of a fixed, but unascertainable amount of eventual energy. No determination has ever been made of the exact rise in temperature of the entering air, in any given instance, nor does it appear likely from the nature of the case, that it will ever be accurately fixed, as the indicator gives us no information on the point.

The safest way to minimize losses in this direction is to lead the air into the cylinders from cool places, in channels or conductors of wood or concrete, or other material which is a bad heat conductor or radiator.

Having the air in the cylinder, we now proceed to reduce its volume and increase its pressure. If this could be done without creating heat, the air would conform to the ordinary law of gases, namely, that its volume would vary inversely to the pressure, and a diagram of the operation in the cylinder would give us an isothermal compression line. In that case, (if it were possible), assuming the air to be originally at one atmosphere pressure, sea level, and 60 deg. Fah., and that we have compressed it to 80 lbs. gauge pressure, the original volume of air taken at 1, would be reduced to .1552, and the mean pressure per stroke would be 27.33 lbs.

It is well to keep these ideal conditions in mind, in order to see how far short of them our actual practice falls.

In the same conditions as above, and assuming no air cooling, the volume of air after compression is .267 of the original unit, and the mean pressure per stroke 36.6 lbs. That is to say, in practice, where no cooling arrangements exist, we require 34% more power for the air compression, because the volume of air has been increased by heat. In the best practice, with all the cooling arrangements possible, or practicable, a result somewhere between the two figures is attainable. The methods of air cooling that have been tried are three, namely:

1.—Water jacketing of the cylinders.

2.—Water spraying in the compressing cylinder.

3.—Cooling in a special apparatus between the compression stages.

As we are treating at the moment of only single stage compression, the first two are all to which we need refer.

Of the two systems under notice, that of water-jacketing, is the one almost universally adopted. In this system however, the cooling effect is at best, very ineffective, since the inner surface of the cylinder can only be slightly cooled, and can therefore only effect a film of adjacent air, leaving the large bulk of air, in the central portion of the cylinder almost untouched. For this reason cylinders of small diameter must allow of better cooling than large cylinders, but other mechanical considerations will outweigh this advantage, where a large output is required. The practice of water spraying in the compressing cylinder has almost been abandoned. The practical objections to it are:

a. that it produces very moist air, which freezes in expanding, and blocks the exhaust passages of pumps, etc., with ice;

b. that it necessitates very large clearances in the cylinders and restricts operations to comparatively low piston speeds;

c. that it gives rise to serious difficulties in the lubrication of the cylinder; increases friction; induces excessive cylinder wear, and reduces efficiency.

If it were possible to utilize the heated air immediately, without loss in volume due to cooling, we should not have to deplore the large power losses represented by the difference between isothermal and adiabatic compression. But in practice the air after compression is discharged into receivers and pipe lines, and returns more or less to its original temperature, with a corresponding shrinkage in bulk, and with lessened energy possibilities Attempts to restore in part the lost energy due to volume shrinkage, are made by reheating the air, near the point at which it is to be used, but it may be said in general, that no reheating apparatus finds a place in mining installations, and therefore no recovery of the loss due to adiabatic compression is made.

It is perhaps well to emphasize the fact that an air compressor has two quite separate and distinct functions to perform, namely:

a. That of increasing the pressure of the air from a pre-existing to some determined pressure;

b. That of discharging the air of a determined pressure into the mains.

We have seen that the admission of the maximum volume of cooled air into the cylinder is the first desideratum in the process of increasing pressure, since the capacity of the machine is reduced, and power is wasted in proportion to the temperature of the air above a certain practicable minimum.

Similarly with the discharge. As the volume of air, owing firstly to the admission of warm air and secondly to the heat generated by the compression, will have greatly increased, the power required for its discharge will be proportionate to the bulk of air discharged. If at the moment compression begins, the air has a temperature of 60 deg. and if it were compressed to 80 lbs. gauge pressure, its final volume would be .1968 of the original volume, if compressed isothermally, or .3144 if adiabatically compressed, and the temperature in the latter case would be 375 deg. In this instance, the volume of air after compression has a bulk of 60% greater than it would have had if the air had been kept down to a temperature of 60 deg. Again if the air at the moment of compression had a temperature of 80 deg. or 20 deg. higher than before, and were compressed to 80 lbs. gauge, its final volume would be .1552 isothermal, or 267 adiabatic, and the temperature in the latter case would be 432 deg. Here the air after compression has a bulk of over 71 per cent greater than it would have had, could the isothermal conditions have been realized. In order to discharge the increased bulk of air therefore we require over 71 per cent more power than would be necessary if the temperature of the air could be retained at 80 deg. F. throughout the operation

The horse-power required to compress 1 cub. ft. of free air to a pressure of 80 lbs. adiabatically is .184 of a h. p., and the power necessary for the discharge of 1 cub. ft. of the compressed air into the receiver, is 1.85 h. p.

The important practical considerations in the figures just given are that:

a. The air is not in a condition to be applied to our purposes, until we have expended a considerable amount of power in the reduction of its volume.

b. The power required for the discharge of the air is to a large extent wasted, because in the conditions we have taken, we must discharge a bulk of 1.71 units of heated air, which after cooling, becomes only one unit available for power.

We may examine further, in the light of the foregoing statements into the pneumatic efficiency of the compressor.

If a normal diagram from a single stage compressing cylinder be examined, it will be seen that it is exactly the opposite of a steam cylinder diagram; steam admission being represented by air delivery; steam expansion by air compression; and steam compression by the air re-expansion line. An interpretation of a normal diagram from a single stage machine compressing free air at 60 deg., to 80 deg. gauge, will show that the work done may be divided as under:

a. Work done in raising air pressure;

b. Work done in excess due to heat;

c. Work done in expelling compressed air to the receiver.

These operations may be expressed numerically as under, having reference to one stroke of the piston:

1.—.734 of the stroke used, at a mean effective pressure of 20.5 lbs. for bringing the air from atmospheric pressure to 80 lbs. gauge, or .734 x 20.5 equals 23.911 stroke pressure units.

2.—The excess bulk due to heat is 71.4 per cent, and the volume of compressed air at 60 deg. is .1552 of the original volume. Therefore the excess work done due to heat is .714 of .1552 or .1108 of the stroke, at the delivery pressure of 80 lbs., or .1108 x 80 equals 8.864 stroke pressure units.

3.—The part of the stroke which furnishes us with power in the receiver, that is for our purposes, the really useful portion of the stroke, is that proportion of it which is required to expel the volume which the compressed air will occupy when cooled, namely 1552 stroke working against a pressure of 80 lbs. or .1552 x 80 equals 12.416 stroke pressure units.

We thus have for the total stroke an aggregate of 36.327 stroke pressure units.

The only portion however, as before stated which provides us with air at working pressure is that referring to the discharge, namely 12.416 units, the remainder being losses in bringing the air up to pressure, and in heat That is to say, we get a useful result only from 34 per cent of the power put into the work, and 66% may be reckoned as loss. Apart from, and in addition to this loss, are the losses inseparable from the machine, as such. To begin with, the volume of air compressed is never the full contents of the cylinder, since there is clearance to be reckoned with, and lateness in reaching full atmospheric pressure, on the admission side. The mechanical losses may be put down at 10% for the friction of the machine, 10% for losses due to increased temperature of the air after admission, 10% for losses due to clearance, leakage, valve resistance, etc. This leaves 70% only available for air compression, and of this available amount of power, we have seen that only 34% does useful work. Then 34% of 70% or 23.8 per cent is all the useful effect we get, expressed in terms of air delivered to the receiver

We have so far dealt with figures relating to single stage compression, and the question now arises, as to what extent the losses in single stage practice will be minimized by double stage compression.

The sole object of double stage compression is of course the avoidance to the greatest extent practicable, of the heat losses, by cooling the first stage air, before it enters the second stage cylinders.

Below are the figures so far as they relate to temperatures, of an actual test. The test was made upon a horizontal cross-compound two-stage compressor, with suction air valves mechanically operated, delivery valves of automatic design to close in equilibrium, air cylinders water-jacketed both on barrel and ends, intercooler between the cylinders.

Temperature of air at intake .. 81.6 F.
Temperature of air, low pressure delivery .....252.1 F.
Temperature of air, intercooler..148.2 F.
Temperature of air, high pressure delivery .....262.4 F.
Pressure of air in intercooler... 34 lbs.
Pressure of air in receiver..... 91.7 lbs.

It is interesting to note the effect of the jacket cooling on the air of the low pressure delivery. The final temperature of the air, without any jacketing would be 310 deg. F. therefore the jacketing has lowered the temperature only 58 deg. and has affected the volume of air therefore, to a very limited extent.

If isothermally compressed, the volume of air would be over 30 per cent less than the adiabatic volume, showing that the water jacketing in this case has given far from an efficient result.

Turning now to the intercooler, we find that it lowered the temperature of the air by 104 deg., but still the air had a temperature of 148.2 deg or 66.6 higher than the original intake, and the capacity of the delivery cylinder would be prejudiced and its useless power increased proportionately to the excess volume occupied by the heated air. The complete cooling which is often claimed in the intercooler, was therefore, far from being realized in this instance.

It is still a matter of opinion amongst many of the best informed engineers on this subject, whether for ordinary working pressures say up to 80 lbs. gauge, there is any advantage in double stage practice. In a booklet published by a well known maker of compressors, the following statement is made:

"The very processes of compounding may too easily lead into mechanical difficulties which in the aggregate, may not only counterbalance the gain by compounding, but may actually swing the balance in the other direction, and result in a machine of lower efficiency, as compared to the single stage machine of the best class."

Following upon the losses incident to the compression and delivery of compressed air to the receiver, we have the losses in the pipe lines and in the machines which utilize the air for power purposes Theoretically the losses in

air mains should be very low, given perfect conditions, and not great distances, but in ordinary mining practice, there is no question that they are frequently very high. A test made under my own supervision in a large South-African mine, showed that the receiver and pipe line losses, amounted to 11.5% of the indicated horse power of the engine. This loss is of course made up mainly of two components, friction and leakage, in what proportions could not be determined. It is probable that 10 per cent would be a fair figure to adopt for leakage and friction in the ordinary mine installation.

We have now to consider for a moment what efficiencies are obtained from compressed air in ordinary mine usage. Rock drilling and pumping are perhaps the principal applications of compressed air power in mines, though it is used for a variety of other operations such as hoisting, signaling, ventilating, etc.

Considered as an engine, the ordinary rock drill is not an efficient machine, since it uses air at full pressure throughout the piston stroke. The average drill developes about 1.5 h. p In order to obtain this power, it has been proved by test that the steam engine working the air compressor must develop anything from 25 to 32 h. p. so that the over-all efficiency of the system in terms of power at the rock drill bit is in the neighborhood of say 5 per cent It seems incredible, that rock drilling operations are so inefficient, but it is nevertheless true, that the above rate is probably representative of the large majority of mine installations.

Pumping by compressed air is largely resorted to in mines because of its convenience, or expediency, or both. On a test made under my own supervision on a large mine, in which all the auxiliarly pumping was done by compressed air, using seven pumps, the efficiency of the pumps as a whole, on the original power put into the compression, worked out at between 9 and 10 per cent. The pumps used were the ordinary steam pump, in which all losses due to clearance, and unsuitability for the pressure used, were greatly exaggerated. Still they represent average practice in this respect, and the losses, similarly to those occurring in rock drilling, are so high as to seem almost incredible.

I have said enough I think about the losses incident to the generation and use of compressed air, to stir up a vigorous defence amongst its champions, from which we must all benefit.

In contradistinction to the losses involved in an air compressing and transmission system in its application to rock drilling I will now state briefly the features and advantages of hydraulic transmission for a similar application.

The outstanding difference between air and water from the point of view of power development and transmission is, that water is non-elastic.

Unimportant as this apparently simple difference is on first view, it will be found on closer examination to describe practical immunity from nearly all the heavy losses incident to air transmission and compression, as under:

1.—There is no initial capacity loss due to increased temperature after admission to the working cylinder.

2.—There is no complicated and expensive mechanism required in developing power, whether the head be gained by artificial or natural means, and there are no large friction losses.

3.—There are no heat losses.

4.—No power is required for the preliminary compression, and in consequence, instead of suffering the tremendous losses incident to the process of bringing the water up to working pressure, all the power is utilized in discharging it into the pressure mains The importance of this is better appreciated, when we state that one unit volume of water at 1,000 lbs. pressure allowing 5% for cylinder and other losses, would transmit 95,000 volume units of pressure, whilst one unit volume of air compressed to 80 lbs. gauge, owing to the small percentage of the stroke available for delivery to the mains, would not transmit to exceed say 2,000 volume units of equal pressure.

5.—There are no clearance losses.

6.—With extremely simple mechanism very high working pressures from 500 to 1,000 lbs. and upwards per square inch may be developed

7.—At working pressures such as mentioned in the previous paragraph, the transmission losses are negligible, and the volume of water required, and the hydraulic mains, are very small.

The over-all efficiency of a hydraulic system, in terms of power delivered to the hydraulic drills would not be less than 80%. The efficiency of the drill would range, according to the type employed from say 60% to 80%. Therefore the over-all efficiency of the entire system would not be less probably than 50%.

On the same basis, the efficiency of a steam-driven compressed-air system will not exceed 6%.

Mexico is a country of water powers, and potential hydraulic transmission projects In view of the great advantages offered by hydraulic transmission and hydraulic drills, it is greatly to the interest of the mining community, to make most careful enquiry into the possibilities of adopting it.

Where natural fall is not available for pressure purposes, a pump of comparatively simple and efficient type is all that is required to develop any working pressure desired.

COPPER FROM SCRAP

C. L. Parsons, in Bulletin 47, of the United States Bureau of Mines, in touching on the recovery of copper from scrap, says that the junk dealer is performing an important service, for all scrap containing copper is eagerly sought, and the copper removed. Copper-wire scrap by the thousands of tons is annually gathered, the insulation, if present, burned off, and the whole simply remelted, poled, and cast again into wire, or into bars or ingots for redrawing. Brass, bronze, coppered tin, etc., of unknown composition, when gathered in endless variety of kind, such as bases of electric lamps, brass and copper turnings and shavings, cartridge shells, broken and battered household goods, old pipe, brass tinsel, moulding sand from brass foundries, concentrates of ashes from brass furnaces, copper paint sludge, and flue dust, much of the miscellaneous collection being briquetted, is treated direct in a copper blast furnace. From this furnace is produced an impure alloy containing about 86 per cent copper, which goes to the blister furnace to make casting copper. In the smelting the zinc, iron, nickel, tin, antimony, and lead present are entirely lost, either in the fume or in the slag. Practically all copper-bearing junk is treated directly to the reverberatories When trimmings or turnings of some special alloy of known composition are obtained in sufficient quantity, they are usually remelted direct with more fresh material of the same composition, generally for re-use in the same works, or the same class of works, from which they were derived, although this kind of material, in a sense, does not deserve to be classed as junk at all. However, a single smelter near New York recovers as much as 10,000,000 lbs. of copper a year from true junk, and many other works throughout the country are resmelting such material.

The Boston Financial News professes ignorance concerning the apathy of the speculative and investing public in the copper stocks. There are none so blind as those who refuse to see. When publications like the Financial News cease to parade as truth statements concerning mines and mining promotions which common sense should suggest to them are unbelievable, they may be able to discern the reason why the public holds aloof.

PRECIPITATION BY ALUMINUM DUST

By E. M. HAMILTON.*

It is hardly necessary to begin this article with a description of the material being treated because the composition of the ores of the Cobalt district has been dealt with by other writers at various times, but before proceeding to the subject of aluminum precipitation at the mill of the Nipissing Mining Co., it may be interesting to explain the circumstances that led up to its adoption.

In the course of preliminary experiments on the ore to find out the conditions of extraction of the silver by cyanide, it was noticed that the solutions, after being precipitated with zinc and used again, rapidly lost their dissolving efficiency. This phenomenon is not uncommon, but I have never before seen an instance where the deterioration was so marked.

At first I thought the trouble might be due to gradual accumulation of reducing agents in solution, because when tested with permanganate, as suggested by Clennell, it displayed considerable reducing power. I do not, however, consider that reducing power, as indicated in this way, is necessarily any criterion of the dissolving efficiency of a solution, because substances may react by the permanganate method as reducers, though they may not have power to abstract oxygen from the solution (e.g., KCNS) and if they do not absorb the dissolved oxygen from the solution, they cannot be classed as reducing agents in the sense of being detrimental to extraction on that account. Still, I thought it a point for careful investigation in this case, and tried aeration of the solution even to an exaggerated extent, and also the addition of hydrogen peroxide and oxidation by electrolysis, but all without effect in improving the dissolving power of the solution. It was then obvious that the trouble was to be looked for elsewhere.

ZINC FOULED THE SOLUTION.

The first thing to come under suspicion was the presence of zinc, seeing that a fresh solution that did not contain zinc gave a good extraction, whereas the same solution after the zinc precipitation gave a bad one, and after a second precipitation, a worse one. By way of following up this suggestion, three extraction tests were made under similar conditions on a sample assaying about 30 oz. of silver per ton. **A** was treated with precipitated stock solution, with the analysis shown in the following table.

B was treated with new solution and **C** with stock solution as in Table 1, but after most of the zinc had been precipitated by sodium sulphide. The ore was ground to pass a 200-mesh screen, and 48 hr. agitation was given with a solution of 0.2% free cyanide.

The residues assayed, **A**, 6.55 oz. Ag; **B**, 2.31 oz. Ag; and **C**, 3.70 oz Ag. This result pointed to the zinc as being the offender, and following this indication, two tests were made on another sample of ore, one being treated with a plain freshly made cyanide solution, and the other with a solution (also freshly made), to which 0.1% of zinc had been added. The residues after 48 hr. were: **D**, 4.28 oz. and **E**, 8.19 oz per ton.

ANALYSIS OF SOLUTION USED IN TEST.

KCN (Liebig)	0.09 %
Alkali (phenolphthalein), in terms of NaOH	0.13 %
Ag, per ton of solution	0.80 oz.
Zn	0.113 %
KCNS	0.069 %
Sb	0.0025%
Cu	0.021 %
As	0.021 %
Fe	0.007 %

It was not at all apparent why the zinc should act in this way, because as a rule I have found that the presence of zinc in solution has no appreciable effect on extraction. On looking through the list of substances in the foregoing analysis, the antimony and arsenic suggested themselves as being the most unusual, and since the amount of the latter was 10 times that of the former, the arsenic was selected as being a possible conspirator.

ARSENIC ALSO A HOSTILE INFLUENCE.

Another series of experiments was thereupon made in which **F** was treated with new solutions; **G** with new solution to which 0.021% arsenic was added; **H** with new solution to which 0.1% zinc was added, and **I** with new solution to which 0.021% arsenic and 0.1% zinc were added. Upon assaying, the residues ran: **F**, 3.22 oz. Ag.; **G**, 4.90 oz.; **H**, 4.78 oz., and on **I**, 7.05 oz. silver per ton.

All these results seemed to point to the fact that the degeneration of the working solutions was due to the use of zinc as a precipitant in the presence of arsenic, and accordingly some other method of precipitation was sought. There was a possible choice of at least three other methods: electrolysis, sodium sulphide and aluminum.

As I have had long experience with electrolytic precipitation of cyanide solutions, and am well aware of its weak points, it was considered to be a remedy of last resort, though a possible one. Sodium sulphide would be a very suitable precipitant for silver solutions, except for two drawbacks. The first is that complete precipitation is not obtained without using an excess of the reagent, which would then have to be removed by a lead compound, the alternative being a tailing solution too high in silver to form an effective residue wash. The second drawback is the recovery of the silver as a sulphide instead of in the metallic state. Attention was therefore turned to aluminum.

ALUMINUM PRECIPITATION SUGGESTED BY MOLDEN-HAUER.

As far back as 1893, Carl Moldenhauer patented the use of aluminum as a precipitant for gold and silver from cyanide solutions. He says in his specification: "Zinc has heretofore been employed in practice by preference in precipitating gold from the cyanide solutions obtained by leaching auriferous ores. The employment of zinc for this purpose is found, however, to be attended with serious disadvantages. Now, I have discovered that aluminum can be employed for this purpose in place of zinc without the disadvantages attending the use of the latter. While zinc forms a combination with the bound or free compound of cyanogen and alkali contained in the cyanide solution, aluminum separates the gold very quickly from the cyanogen solution without entering into combination with the cyanogen, but simply reacting with the caustic alkali which is present at the same time. By the action of aluminum, the cyanide of potassium employed for leaching the gold out of its ore is regenerated, which is not the case when zinc is employed But the zinc does not confine itself to entering into combination with the cyanogen compounds of the gold, but also acts upon the free cyanide of potassium contained in the solution, so that a great part of the latter is consumed, but this is not the case when aluminum is employed. These results are of the greatest importance when the solution separated from the gold is to be employde in subsequent gold-extracting operations, as the whole of the cyanogen in the regenerated and liberated cyanide of potassium is enabled to renew its action, but the lyes resulting from the em-

* Nipissing Mining Co., Cobalt, Ont., in Engineering and Mining Journal, May 10, 1913.

ployment of zinc cannot be employed with the same advantage in subsequent operations of the gold.

"Numerous attempts have been made to regenerate the zinc, but are found to be inconvenient and costly. It is consequently evident that an important saving in cyanide of potassium is obtained by the employment of aluminum."

ALUMINUM FORMS NO CYANOGEN COMPOUND.

The inventor does not appear to have developed the idea on a practical scale, but it is worthy of more attention than it has received, because, as he points out, owing to the fact that aluminum does not form any compound with cyanogen, not only is the whole of the cyanide recovered which was combined with the precious metals, but also the additional loss of cyanide by direct combination with the zinc is avoided. In the case of solutions strong in cyanide the latter loss may be considerable.

Some may dispute the ground I take when I count as lost the cyanide that remains combined with zinc, because it is often stated that the double cyanide of zinc and potassium is almost as efficient for dissolving purposes as the simple cyanide. My experience is, however (at any rate in the case of silver ores), that the reading obtained by the use of KI indicator with excess of caustic, is worthless as a measure of the dissolving power of a cyanide solution, the efficiency being for practical purposes proportional to the "free" cyanide reading obtained by stopping at the first faint opalescence without the use of KI indicator.

CAUSTIC ALKALI NECESSARY.

The fact that aluminum does not replace the precious metals in the cyanogen compound, renders necessary the presence of a caustic alkali, the reaction probably occurring theoretically thus:

6 $NaAgCY_2$ plus 6 NaOH plus Al equals 6 Ag plus 12 NaCy plus 2 $Al(OH)_3$,

the aluminum hydroxide at once dissolving in the excess of caustic to form sodium aluminate,

2 $Al(OH)_3$ plus 2 NaOH equals $Na_2Al_2O_4$ plus 4 H_2O.

If this explanation be the correct one, it should be possible to make one part of aluminum precipitate 12 times its weight of silver, but in practice I have so far not been able to reach this proportion. Perhaps in the case of low-grade solution, when caustic and aluminum are both present in excess, as must usually happen in practice, the following may more nearly represent what actually goes on:

2 $NaAgCy_2$ plus 4 NaOH plus 2 Al equals 4 NaCy plus 2 Ag plus $Na_2Al_2O_4$ plus 4 H.

In this case, one part of aluminum would precipitate four times its weight of silver, and this figure approaches more closely the actual proportion I have found in practice, which is about three of silver to one of aluminum. For zinc precipitation Clennell gives the following equation:

$NaAgCy_2$ plus 2 NaCy plus H_2O equals Na_2ZnCy_4 plus Ag plus H plus NaOH;

and according to this, one part of zinc will precipitate only 1.7 times its weight of silver. This zinc reaction is also worthy of comparison with that of aluminum from the fact that two molecules of free cyanide appear to be used up in addition to the two molecules of cyanogen in combination with the silver.

The consumption of cyanide by direct combination with the zinc is illustrated by Clennell as follows:

Zn plus 4KCy plus 2 H_2O equals K_2ZnCy_4 plus 2 KOH plus H_2.

The indications then would go to show that quite apart from any detrimental action that zinc may have upon extraction of the precious metal from its ore, the substitution of aluminum should be, on its own merits, a valuable improvement, and I shall try to show later on that this proposition is borne out in practice.

ALUMINUM SUCCESSFULLY USED AT DELORO, ONTARIO.

Although twenty years since Moldenhauer so ably explained the advantages of aluminum over zinc, the commercial application of the process is almost unknown. In 1893, H Forbes Julian experimented with it (cf. Julian and Smart, "Cyaniding Gold and Silver Ores"), but does not seem to have met with any practical success. He first used vertical aluminum plates set ¾ in. apart in a standard precipitating box, but, owing probably to lack of surface, the result was unsatisfactory. Afterwards he used shavings, which showed a great improvement, but in time the metallic surfaces became coated with alumina, which impeded precipitiation to a prohibitive extent. He was unable to overcome the difficulty, and finally abandoned the attempt to make use of the process.

The first instance I have been able to find of its successful commercial application, was at the Deloro smeltery, Ontario, where it was introduced by Prof Kirkpatrick for dealing with a rich cyanide liquor resulting from the treatment of some special products. Warned, probably by Julian's failure, and having before his mind the wide use of zinc dust, he conceived the idea of applying the aluminum in the form of a powder, by which means he overcame the obstacles encountered by Julian, and made the process a perfect success.

In 1910, Kirkpatrick took out a patent for a special tank designed to effect a proper mixture of the dust with the solution. The difficulty in the use of aluminum dust is to get it to sink, because it is not easily wetted, and even when wet, tends to rise to the surface of liquid through the buoyancy imparted by minute hydrogen bubbles, unless a violent agitation is maintained. Kirkpatrick overcomes this trouble by using a tank having a vertical shaft at its center, carrying one or more screw propellers, which, when revolved by a suitable power connection, forms a vortex in the center of the solution to be precipitated.

A sufficient quantity of the dust is then added, and as it spreads out on the surface, the vortex sucks it down to the bottom, whence it passes outward towards the periphery and up again to the surface, again to be sucked down at the center. This motion is maintained until precipitation is complete, when the whole charge is pumped to a filter press for the separation of the precious metal. The same process has been in use at the O'Brien mill in Cobalt for three years or more in precipitating the working solutions in the cyanide plant and has apparently given entire satisfaction

RATE OF PRECIPITATION DEPENDS ON VIOLENCE OF AGITATION.

Before finally adopting aluminum as the precipitant for the mill, a series of laboratory tests were made, which showed that not only was the combined cyanide liberated, as indicated by titration, but also that no deterioration of the solvent power of the solution was apparent after using and precipitating a number of times.

The above mentioned tests showed, among other things, that the rapidity of precipitation depended to a large extent on the violence of the agitation used for mixing and that whereas a charge shaken up briskly in a bottle would have its reaction completed in about two minutes, a large charge stirred up in a tub with a stick needed from 10 to 15 min., other conditions being equal. It, therefore, seemed that it should be possible to get away from the intermittent system represented by the Kirkpatrick method and work more on the lines of the continuous zinc-dust precipitation. The appliances for the latter process, making use of the Merrill machinery, had already been installed, including clarifying press, dust feeder, emulsifier and two triangular presses. It was evident, however, before making a start, that more time for contact would be required than had been provided for the zinc dust by the 200 ft. of pipe line between the emulsifier and the press It was also evident that it would be difficult

to feed the aluminum dust, even as an emulsion, into a stand-pipe connected with the pump suction, because, as already explained, the dust is difficult to wet, and even after it has been wetted, it will soon tend to rise to the surface and float as a thick scum unless a brisk agitation is maintained. If it were fed into a stand-pipe it would collect on the surface of the liquor and gradually fill the pipe instead of being drawn down into the current flowing to the pump. Therefore, the following modification of zinc-dust practice was adopted and was found to answer admirably.

MODIFIED ZINC-DUST APPARATUS USED FOR ALUMINUM.

Referring to the accompanying illustration, 1 is the pregnant solution storage tank from which the solution passes to a triplex pump and thence to the clarifying press 4. The tank 5 is now superfluous, having been installed as a storage for the zinc-dust process, but the clarified solution falls into it as previously arranged, flowing out again at once by the launder 6 into tank 13. The feeder 7 for the aluminum dust, which discharges directly into the stream of solution, flowing in the launder 6. The emulsifier supplied for zinc dust has been eliminated as not serving any useful purpose in the present process. The launder is fitted with a cover and has a flap of canvas hanging over the discharge opening to avoid loss in dusting. Tanks 13 and 14 are about 6 ft. deep by 5 ft. in diameter, and have a central revolving shaft to which are bolted vertical planks extending from the bottom to the surface of the liquor contained therein. These comparatively narrow vertical strips when revolved at about 60 r.p.m., form an efficient agitator for mixing the emulsion and render unnecessary the propellers with their vortex effect described by Kirkpatrick

It will be noticed that tank 13 is always full and that the emulsion has to pass down to the bottom and up the 6-in. connecting pipe in order to reach tank 14 and to avoid any tendency for heavy silver precipitate to accumulate in the bottom of tank 13, the revolving shaft has a pair of long arms or paddles about 3 in. wide, bolted on just above the bottom to keep such heavy particles in suspension, until they can be sucked by the current up the vertical pipe into the next tank 14. This latter tank may be considered chiefly as a pump feeder from which the emulsion passes to the triplex pump 18, and thence to the precipitate press.

CONSTANT LEVEL AUTOMATICALLY MAINTAINED.

In order to maintain a constant level in tank 14 and avoid overflows on the one hand and the entrance of air into the pump suction on the other, a system of automatic control valves operated by a float, is used. It will be seen on examining the sketch that each pump is provided with a bypass, 21 and 24, and both these are operated by a single float shown at 23 in the drawing. The valve 25 which is usually more or less open, is operated by a long lever which is hinged in such a way that it can be bent upwards from the hinge point, but not downwards, and is normally held in a straight line by the weight 26. The vertical rod passes freely through a slot in the lever and carries a tappet in such a position as to engage the lever at a certain height. When it is desired to increase the flow to the precipitate press, the float will rise in the tank until the tappet engages the lever, thus gradually closing the bypass valve 25 and throwing more work onto the pump. The flow may thus be increased until valve 25 is completely closed, this point representing the full capacity of the pump 18. If then, the flow into the tank be further increased the float will continue to rise and the lever will flex at the hinge, thus causing the upper tappet to engage the lever on valve 22 and by opening the same, allow the surplus solution to flow back to tank 1, whence it came. With this device, it is perfectly simple to get any desired flow of solution up to the full capacity of pump 18, maintaining practically the same level in the pump-supply tank. The total time consumed between the point where the precipitant is added and the point where the emulsion enters the press, is from 10 to 15 min. on the average and precipitation is normally complete in this period.

ALUMINUM-DUST FEED REGULATED BY SOLUTION TEST.

The feed of dust is regulated from time to time by taking a sample of the effluent from the press and adding a little strong sodium sulphide solution to it. If the faintest coloration appears (due to the formation of silver sulphide), the feed is increased little by little until the test indicates complete precipitation. The effluent is tested in this way every hour or so and a fine adjustment of the feed is thus obtained.

It has already been stated that caustic alkali is necessary for this reaction, and therefore caustic soda is added to the pulp before cyanide treatment in sufficient quantity to bring the solution up to from 2 to 3 pounds NaOH per ton. In connection with the alkalinity of solutions, there is an important point to be noted. Lime must be reduced to the smallest quantity necessary for slime settlement, because it tends to form with the dissolved aluminum an insoluble calcium aluminate, which collects in the precipitate press, giving a low-grade product and one almost impossible to melt by the usual methods. It is therefore necessary, to ascertain whether the slime will settle readily in a solution high in caustic and low in lime and also whether the use of caustic interferes in any way with the efficiency of the solution for extraction. I may say that neither of these points has so far given any trouble at the Nipissing mill.

PRECIPITATION RESULTS GOOD.

At the time of writing, this process has been in use about four months, so the data available should be fairly reliable. The figures for the first three months of 1913 are here given just as they stand in the official records and include the "bad days" as well as the good ones. These

PRECIPITATION RESULTS.

Month	Head Assay, Tail Assay, Precipitation		
	oz.	oz.	%
Jan....	8.23	0.23	97.2
Feb....	8.56	0.21	97.5
Mar....	8.50	0.15	98.2

figures do not represent the full efficiency of which the process is capable, because a few bad assays due to mistakes and oversights, which are unavoidable in stating a new mill, have spoiled the averages. Usually the daily assay stands at about 0.05 oz. silver in the tails and with ordinary care there is no reason why it should ever run over that figure.

CONSUMPTION OF ALUMINUM.

Month	Aluminum Consumed, Lb.	Silver Precipitated, Oz.	Aluminum Used per oz of Silver, Lb.
Jan....	2926	141237	0.02
Feb....	2742	143141	0.019
Mar....	3014	142964	0.021

For comparing these figures with those for zinc dust, it is not easy to obtain representative data on the latter owing to the custom of publishing such figures in terms per ton of ore instead of per fine oz. of precious metal. I have, however, come across the following table in the Journal of the Chemical, Metallurgical, and Mining Society of South Africa for December, 1909, which may be of some assistance.

CONSUMPTION OF ZINC DUST PER OZ BULLION.

Oz Au + Ag Ret'd per Sol'n.	Lb Zinc Dust Consumed per oz Au + Ag Ratio Precipitated		Remarks
0.02	2:2	6.60	Homestake low solution
0.15	2.2:1	0.91	Homestake weak solution
0.47	1:1	2.5	Cerro Prieto
0.49	1:4	5.57	Cerro Prieto
0.70	1:4	0.42	Cerro Prieto
1.84	1:19	0.19	Mother Lode, W. J. Sharwood
3.29	1.99	0.16	An American mill

It is impossible to say what the zinc-dust consumption would have been at the Nipissing low-grade mill, because it was never tried there, aluminum having been used from the start. The above table shows, however, that the figure var-

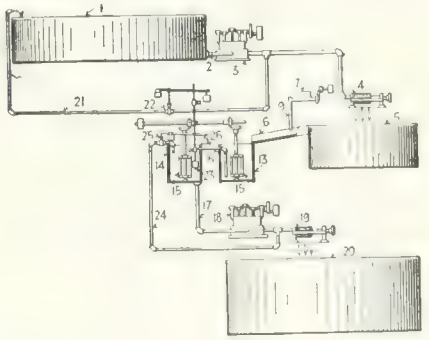
ies enormously with varying conditions and that, as far as the series is carried, the higher the metal content of the solution, the less the zinc dust consumption per ounce, so presumably the consumption on Nipissing solution would have been lower than the lowest in the series. On the other hand, the strength of cyanide in the solution, 0.2 per cent, would tend towards a high zinc consumption by direct combination. All things considered a consumption of about 0.1 pound zinc per ounce of silver would probably not be far out as an estimate for comparison with the actual aluminum consumption shown.

REGENERATION OF CYANIDE, AVERAGE OF DAILY TITRATIONS

Month	Titration % KCN Head	Tail
Jan.	0.196	0.225
Feb.	0.181	0.215
Mar.	0.179	0.215

Month	Gain After Precipitation Per Lb KCN Cent.	Per Ton of Solution
Jan.	0.032	0.64
Feb.	0.034	0.68
Mar.	0.036	0.72

The regeneration shown above approximates closely the actual amount of cyanide combined with silver in a solution as-



saying 8.5 ounces per ton. It must not be forgotten, moreover, that the cyanide shown to be actually recovered does not represent the total saving effected, because, as already pointed out, there is in the case of zinc precipitation a loss of cyanide by direct reaction with the zinc.

Before we appreciated the deleterious effect on this process of lime in the working solutions, the precipitate presses contained a good deal more calcium aluminate than silver the latter being sometimes as low as 10 per cent. At present the precipitate assays under normal working conditions, between 25,000 and 27,000 ounces per ton, or from 85 per cent to 92 per cent silver. This product may be melted in crucibles without any flux, yielding bullion about 990 fine. At the Nipissing, it is briquetted with a little soda and borax and melted direct in the oil-fired reverberatory already described in the Journal, producing bullion over 997 fine.

The present price of aluminum dust laid down at the Nipissing including freight and duty (15 per cent ad valorem), is from 35 to 39 cents per pound, and of zinc dust 7 cents per pound. Taking the consumption of the two reagents at the figures already given, 0.02 pound per ounce of silver for the first, and 0.1 pound for the second, the ore yielding 20 ounces of silver per ton would show as in table:

COMPARATIVE COST OF ZINC AND AUMINUM METHODS.

Aluminum Dust.	
0.4 lb. aluminum at 38c	$0.152
Caustic soda, 1.5 lb. at 2½c	0.033
Per ton	$0.185
ZINC DUST.	
2 lb. at 7c	$0.14
Per ton	$0.14

In the figure for caustic soda, 0.5 pound has been allowed for chemical consumption and 1 pound for mechanical loss.

To offset the extra charge of 4½ cents per ton of ore, there would be a direct recovery of 1.6 pounds of cyanide, at 15 cents or $0.24 per ton; a further saving in cyanide, varying in amount with varying conditions, due to the absence of any action between the precipitant and the cyanide, a saving in the cost of smelting and refining and in some cases, in marketing the bullion. In the case of ores which, on a commercial scale fail to yield the extraction predicted by laboratory work on account of fouling of working solutions, a gain in extraction is obtained which may often amount to 7 per cent, and which in the case of some of the Nipissing ores was as high as 14 per cent.

As an alternative to the use of the dust, Charles Butters, consulting metallurgist for the Nipissing Mining Company, has suggested the use of aluminum granulations placed in a revolving tube mill through which the solution to be precipitated is continuously passed, the attrition produced thereby serving to scour the metal surfaces and thus obviate the principal obstacle encountered by Julian in his experiments.

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Additions of phosphorous up to 1.06 per cent, of manganese up to 1.49 per cent, and of tin up to 1.46 per cent, increase the tenacity and hardness of copper, but decreases its elongation, electrical conductivity and specific gravity. Annealing affects these alloys in a similar way; tenacity and hardness are diminished, elongation is increased, while the density and conductivity are scarcely changed.

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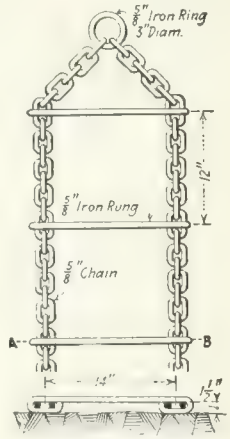
Exports of gold and silver to the Orient from London in 1912 were the largest in 34 years, excepting 1906 In 1906 the movement totaled 14,345,474 pounds sterling, while in 1912 exports amounted to 15,565,334 pounds.

CHAIN LADDER FOR SINKING

The use of iron ladders, especially chain ladders, is necessary in cases where they are exposed to much blasting. They are thus adapted to raising and sinking operations. In sinking particularly, considerations of safety should lead to the providing of a ladderway to the very bottom of the shaft, to afford of exit in case of failure of the hoisting apparatus. This is a precaution often inexcusably neglected. A chain ladder is well suited for use in the shaft bottom, for extending the wooden ladderway. It need be moved only occasionally, the superfluous length being allowed to coil on the shaft bottom, except during firing, when it can be drawn through itself som way up. It can be easily handled in 30-ft. sections.



A method of constructing such a ladder is shown in the illustration. The chains and rungs are both made of ½ or ⅝-in material, and the rungs are spaced about 12 in. vertically and the chains are about 14 in. center to center. The ends of the rung pieces are heated and bent to the proper shape to fit over the links, then reheated and pounded down on the links and hooked around at the ends in their proper position, thus obtaining a snug fit. It is advisable to so hang the ladder that the doubled ends lie against the rock side, which provides a space for the hands, in climbing. The chains at the top can be caught into a 3-in. ring for suspending the ladder.

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The deepest borehole in the world is reported to have been put down in Silesia near Czuchow. The total depth of this hole is given as 2,240 metres (7,347.2 ft.), or a mile and one-fifth. The work cost an average of $10.90 per foot. This is an excessive cost, as at a depth of 4,920 feet it became necessary to enlarge the diameter of the hole.

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The United States standard gold coin contains 900 parts gold, and 100 parts copper.

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CONTENTS: PAGES

The Wall Street Journal is responsible for the weird story that there is a man in Wall Street, who, for thirty years, has invested or speculated in mining stocks on a system, and has not yet cashed a bet. He bought only the cheapest stocks, paying in no case more than 15c. per share, expecting, of course, that most of them would prove worthless, but hoping that some few might appreciate in value, and make the speculation, as a whole, a winning one. The net result of his operations is that, in the period of thirty years, he has accumulated 1,298,404 shares of 155 different varieties of mining stocks, that the stocks stand him in $125,000, that none of them ever paid a dividend, and that there is now a bid price for only four of the 155 varieties. His holdings of these four he could sell for approximately $250.—Engineering and Mining Journal.

He also could have loaded up on [illegible] stocks" at many dollars per share years and years ago and witnessed their decline to nothing—with regular assessments added, and still being called for—while, within the past few years he could have secured reams of the highest-priced wall paper in the world and have seen it degenerate into the poorest kind of wrapping paper.

TIPSTERS AND TIPPEES IN THE MINING BUSINESS

One of the most pernicious and insidious practices ever evolved for the furtherance of selfish, dishonest gain and prominence in the business of mining is that of "tipping." The definition of the word and the field of operation it covers is only feebly comprehended by dictionary editors and its baleful influence is so far-reaching that to even imperfectly conceive what it amounts to must necessarily involve years of active life in the atmosphere which it permeates and a clear sense of the object sought in the employment of the art—for it is an art of the most subtle kind.

The tipster in the mining business is not to be confounded at all with the social tipster; nor is the tippee to be confounded with the fawning, servile being who accepts the quarter, half-dollar or other small sum for the closer attention or better service he is expected to (or does) render the tipster—not at all. The tippee in mining is a diverse entity—perchance genderless and maybe characterless—whose influence, once brought under subjection by the tipster, is wielded as a bludgeon or shield (as occasion demands) in destroying opposition to or warding off public criticism and comment upon, schemes being worked to fleece the public. The tipster in mining is usually a broad-visioned fellow and a good judge of human nature; he is jovial, suave and companionable and when his snare enmeshes the tippee whose influence and support he has been working for it feels so comfortable that the ensnared scarcely realizes the discomfort that must follow the inevitable awakening to the fact that he has been "bought" and MUST, thereafter, play the game without protest.

Who are the victims of the mining tipster? Their name is legion. The tippees—as illustrating the classes about which this article is written—are those who are more or less unconsciously made to serve the purpose of the tipster in luring "investors" and "speculators" to their doom. The real victims are the purchasers of the inflated, watered, boosted, boasted and bolstered stocks of corporations, the promoters of which expect to make their REAL MONEY through the distribution of shares and the manipulation of both mines and markets. The investing and speculative public has been educated to believe that most of the crooked business in mining exists only among promoters of what are popularly termed "wild-cat" propositions and this confiding belief is what has made it so much easier for the "wolves in sheep clothing" in the "legitimate" field of mining to command a prestige and following which they do not deserve.

The common "wild-cat" promoter secures the majority of his victims through depicting in glowing terms the successes of others. His methods are largely tinsel and show—blase and crude. He captures the ignorant and unthinking classes—those who readily are made to believe that gold grows on trees—that it is easy to get returns of $1000 for $1. The "wild-cat" promoter also works the tipping system as best he can, but he never becomes a graduate of the scientific class that makes it yield millions—that reduces the business to an art—and he never reaches the class that worship at the shrines of the real masters of the game. It is only during wild boom periods that the "wild-catter" gets past the "penny ante" stage of mining the public and the real, legitimate investors and stock speculators would not listen to him for a minute; they prefer to be soaked right and soaked hard—through their best friends, perchance—so that they will have something to remember; even though they are never able to quite understand why and how they came to be bumped.

In "high finance" mining the tipster employs the most subtle methods. He first of all reaches out and cultivates the friendship and good will of the newspapers, particularly those published in the region of his company's contemplated operations. Does he buy advertising space in the paper? Does he attempt to buy the editors and thus dictate the policy of the publication toward his "enterprise?" Be certain that

he does nothing of the kind. He knows, to begin with, that the paper at least poses as a friend and booster of the community in which it exists; that he must not attempt to control its policy as far as it relates to treating kindly any new and "tremendously important" enterprise that is being launched, and so, after the first announcements are made in big type and the paper has painted the finest picture it can, the tipster usually affects a shyness for publicity; he prefers to let the undertaking "speak for itself," etc., so that when information is released the reporter and the paper's management may properly appreciate his condescension in submitting to interview.

As the "enterprise" is rounded into form and the time approaches for properly impressing the public with the magnitude and worth of the proposition from an investment standpoint, the tipster begins to play his hand. He eventually tells the reporter how much he appreciates the way he treated the information he had released from time to time, and probably says something like this:

"Now, to show my appreciation of the way you have treated me—and assuring you that this invloves no future obligation on your part—I am setting aside a small block of the stock in this company to be sold to you at the present price whenever you see fit to exercise this option. The stock is worth a great deal more than it is now selling for and I sincerely hope and believe that within six months (or any time agreed upon) you will be able to reap a handsome profit. You see I am not giving you anything; I am simply carrying this stock at the price I buy it for today so that you may reimburse me when the right time comes and make whatever profit there may be in the transaction. To give you the stock might be construed as bribery and I am not in the bribing business; it is not necessary to the success of our enterprise that we do anything that is not absolutely legitimate in business; but you know that already. I feel obligated to you for the way you have treated me in the past and this little turn, which costs me nothing, is intended simply as a slight recognition of my appreciation. Please say nothing more about it."

From the minute that reporter left the office of the tipster he became the willing, or unwilling (possibly) slave of that tipster, did he not? While the tipster gave him to understand in no uncertain manner that no obligation attached to that transaction, both were conscious of the fact that a relationship had been established that would allow, on the one side, supplying of any kind of "boost" information to that reporter's paper in the future with a certainty that it would be used—and on the other, no chance to escape. The reporter knew he was "landed," so the only thing to do was to boost as hard as he could and make as much as possible out of his stock option. That reporter had not been bought, in the accepted definition of the word, but he was a tippee, just the same, and placed, so far as that particular proposition was concerned, "hors de combat."

But the work of this tipster has only just begun. This is no ordinary undertaking. It involves the expendieure of millions of other people's money in rounding it out and, before the stock can be unloaded at soaring prices, bonds must be sold. The papers must help—and they do help. Maybe the proprietors are directly—or through the tipped reporter—advised that these bonds are to be made convertible into company stock at a certain price after a certain time. As little of the stock has yet found its way into the hands of the public it costs nothing to move the price up. The newspaper owner or publisher understands this and he buys a block of the stock on margin. As soon as the conversion mark is reached he sells out, make HIS profit, and also becomes a tippee. His paper, then, is a bought booster for the game and it has no chance to escape and indulge in any criticism of Mr. Tipster's "world-beating" (and the word beating is used advisedly) enterprise.

With the foregoing illustrations of how the mining promotion game is played, in both high and low degree, is not the reader able to comprehend, or understand, at least some of the reasons of why a number of noteworthy propositions have been apparently successful during the past few years?

Does this recital not bring to view a glimpse of the schemes that have been perpetrated in many of the big copper and other flotations which have been monopolizing public attention so long? And does it not suggest that most of the public utterances concerning them need careful weighing before credence is allowed?

Going back over the history of Utah Copper, Ray Consolidated, Chino Copper, Braden, Yukon Gold, Butte & Superior, Alaska Gold Mines, etc., it should not be hard for those who have been following the course of events to appreciate why the daily press has been made subservient to the wishes and the demands of the promoters, and why it has been simply impossible to get disinterested and truthful information concerning the REAL MERITS AND WORTH of any of them. If the newspapers of the country which specialize in mining information have become corrupted and their utterances are no longer to be trusted, what must be expected from sheets controlled by brokerage houses, the modern mining "MARKET LETTERS," etc.? If the tipster is able to control the public press along lines indicated by this review of conditions, why should a prospective investor, or a speculator, expect anything but loss if he relies for tips on market letter information.

SEEKING PASTURES NEW

When a fisherman finds that a stream has been "whipped" too hard and that the fish are shy and scarce, he breaks camp and goes somewhere else; when the stockman finds his herds have cleaned up one range he moves on to another—he seeks new pastures. By the same tokens it stands to reason that when mining promoters find "thin picking" in an overdone section of the financial, speculative and investment world they, too, will seek a less-worn field in which to operate. These and kindred reasons are presented by those learned in the art of successful prognostication as accounting for the reported determination of the promoters of the Alaska Gold Mines scheme to establish headquarters in San Francisco of the "vice-president, in charge of operations."

According to a recent arrival from San Francisco the tip has already been passed to the "inner financial circle" of the coast metropolis that the low-grade porphyry, gold and zinc crowd is going to show the natives how little they know—or ever have known—about the gold mining game. The coast financiers and the coast investors and gold miners are going to be given free kindergarten instruction in the art of mining, milling and smelting Alaska gold ores for seventy-five cents a ton or less. As a result of this education it is promised (so our San Francisco informant claims) that the coast investors will fall over each other in their frantic efforts to play the game. As the west-coasters have never taken to the low-grade porphyry copper mining business on account of their preference for gold mining, it is figured that they know nothing of the deceptive methods that have been practiced in the eastern and foreign markets to fleece the public.

But our San Francisco friend assures us at the same time, that those who are accredited with the preparation of this

move on San Francisco, are destined to brush up against the "real thing" when they undertake an invasion of the jealously guarded preserves of the coast money kings; that they will encounter a combination of princely entertainers who will "go them one better" in any move they make and see to it, at the same time, that their own money stays at home; while any contributions that the invaders feel disposed to make will be as graciously received as was F. Augustus Heinze's "wad" when he undertook to show the easterners how to do a banking business.

From this point the play of the "invaders" will be watched with keen interest, and particularly by those who, through their "investment" losses, have been unwilling contributors to the invasion "jack-pot."

FIGHTING THE SMELTER TRUST

Apparently Sidney Norman who, as a minority stockholder in the Federal Mining and Smelting Company, is conducting the suit for the abrogation of the robbing smelting contract with the American Smelting & Refining Company, seems determined to carry the fight as far into the ranks of the enemy as possible. His latest move was to send a letter to the president of the United States through Senator Poindexter in which he called attention to the activities of the Smelter Trust in the matter of revision of the tariff on lead. About the first of the month the dispatches told of the letter having been submitted, but only a slight inkling of the contents of the document was given by the papers. Knowing that western mining interests would be deeply interested in the subject a copy of Mr. Norman's letter was sent for. It reads as follows:

"I have read with great interest [illegible] protest against the insidious efforts of the lobbies maintained by special interests at Washington to further their efforts to confuse the public mind in the matter of tariff revision and take [illegible] announcement as an invitation for [illegible] citizens to strengthen your hands by giving publicity to specific instances of [illegible] tactics.

"I am a plaintiff with other minority stockholders of Federal Mining & Smelting Co. in a suit which has been brought in the Supreme Court of New York against the American Smelting & Refining Co. and the Guggenheim interests, in which we allege fraud in the execution of a [illegible] contract between the American Smelting & Refining Co. and the Federal Mining & Smelting Co., both of which corporations are controlled by the Guggenheims. In the preparation of this suit I have had occasion to investigate the metal schedule of the tariff bearing on lead and have also learned something of the [illegible] methods being employed by the Guggenheims and the so-called 'smelting trust' to distort the real position of affairs in the hope Congress could be induced to retain the present level of protection upon lead ores and bullion.

"Early last year the [illegible] of Federal company were [illegible] to [illegible] a circular letter to each stockholder calling attention to the probability of revision of the metal schedule under Democratic administration, predicting dire disaster to their investment (a ready nearly wiped out by the dishonest methods of the trust) and asking each stockholder to use every possible pressure upon the congressional delegation from his particular district to secure retention of the present protective tariff on lead.

"About the same time holders of preferred stock, a 7% cumulative issue of $12,000,000 in $100 shares were notified that their dividend rate would be reduced to 6%, in spite of the fact that the company's treasury contained ample surplus for full dividend purposes and that the current earnings were more than sufficient to provide the difference. Stockholders who protested against this reduction were informed by a prominent official that the decrease was but temporary and was in the nature of a manufactured argument in favor of retention of the present lead tariff to be used before the Ways and Means committee of the House of Representatives.

"The principal arguments against the reduction were presented by the Coeur d'Alene Mine Owners' Association and a similar organization of Utah. The tariff activities of both of these organizations have been directed and controlled, either directly or indirectly, by the Guggenheims and their smelting corporations. Representatives of these organizations appeared before the Ways and Means committee in fact, though not in name, as the lobbyists of the smelting trust, stating orally and in briefs that the mines of the Coeur d'Alene district received for their product during the years 1909-10-11 the full New York market price of an average of $[illegible] per hundred pounds of lead, when, as a matter of fact, they received but $3.84 per hundred pounds. These lobbyists also threatened a decrease in miners' wages or total cessation of work in event of a material reduction of the lead schedule. Through its control of the Federal Mining & Smelting Co., from which it exacts an illegal tax of from $600,000 to $1,000,000 a year through a fraudulent contract that runs for twenty-one years, the trust controls practically 50% of the entire output of the Coeur d'Alene district. Other smelting contracts covering mines which they do not control give the Guggenheims monopoly of practically 75% of all the lead derived from the district. In Utah simi'ar conditions exist, although I am not at this time able to quote exact figures.

"Analysis of the briefs now on file and perusal of smelting contracts then in effect with the trust will prove that my assertions are correct and that the trust during the three years covered by the briefs absorbed in initial charges no less than 37% of the total protective tariff paid by the nation for encouragement of the actual producer. Investigation of local conditions will also conclusive'y prove that the balance of such protective tariff was more than completely absorbed by a wholesale manipulation of shipments which exacted long-haul rates from the producer and delivered his product at a short-haul point.

"Prominent among those who have represented the trust at Washington during the present agitation is Harry L. Day of Wallace, Idaho, president and general manager of the Federal Mining & S. Co. by virtue of control of that corporation by the trust, who draws a salary of $15,000 a year from the pockets of stockholders ostensibly to protect their interests, but in reality to further the machinations of his real employers, the Guggenheims. Mr. Day is also part owner of the Hercules mine in the same district which now ships its product to the trust under a more favorable contract than is granted to other producers.

"I bring these facts to your attention in the hope that knowledge of them will aid you to fortify yourself against the efforts of the smelting trust, which has [illegible] maintained its own personal lobby in the Senate chamber in the person of Mr. Simon Guggenheim and which now seeks to bulldoze and mislead you through its agents. Any expert upon the condition of the lead industry will be able to prove to you that the world's production is now short of consumption, that this country has probably reached its production zenith and that, within a very few years, the United States must become a buyer instead of a seller in the world's markets. Such an expert could also give you some interesting data as to the reason for the present low quotation on lead, which has fallen nearly 75c. per hundred pounds since last November in the face of a normal business demand.

"My position as the owner of stock in a lead-producing corporation and a supporter of your tariff plans may be considered anomalous by many others similarly situated, but it is evident to me that the tariff question will never be settled for the best interests of all the people until immediate personal profit is in measure forgotten. Personally I am of the opinion that it is both absurd and iniquitous to further fatten the smelting trust of the Guggenheim brothers by taxation of the nation at large. I almost believe that in the long run the nation would experience less loss by closing every lead mine in the country for a period of years, if by so doing it could be rid of a ruthless, blood-sucking organization, without honesty or knowledge of square-dealing, which now constitutes a tremendous menace to the whole mining industry and particularly to the small producer."

STIRS UP NEW YORK EXCHANGE

Following is a copy of a letter addressed by Sidney Norman to the President and Board of Governors of the New York Stock Exchange, on the 17th of the present month:

I acknowledge receipt of your communication of the 13th inst. in which you violate all the rules of justice and fair play in denying me copy of alleged "satisfactory evidence" upon which you base the opinion that the American Smelters Securities Co. did not control Federal Mining & Smelting Co. when the former was listed on your exchange in October, 1909.

Such opinion natura'ly means that you have elected to ignore the stock books and other records of the company and in their place accept the unsworn, unsupported word of the very official accused of the original deception. It also implies your belief that the affidavit filed by me cannot be substantiated. My reply to you is that every allegation therein will be fully proven at the proper time before an impartial tribunal, thus also establishing the fact that the New York Stock Exchange will go to any lengths to protect those who are financially powerful and that it cares nothing for the public losses made partially possible and in some cases criminally easy by the lax methods of its own committees.

There is another feature of this matter which you have possibly overlooked. If Mr. Brush's secret statements are to be given credence it naturally also means that the public advertisement of M. Guggenheim's sons in in the New York Times of Dec. 21, 1911, was a deliberate lie specifically published for the purpose of misleading the public by further concealing control of Federal. Consequently, if I am well advised, either these statements or the advertisement constitutes a misdemeanor under the New York criminal statutes.

The matter will by no means be allowed to rest where it is and you will yet be given an opportunity of showing the public what you consider "satisfactory evidence" in such cases. Meanwhile the reason for the unfortunate position occupied by your organization in the eyes of the public will be better understood and 2,000 stockholders of Federal, including 700 women dupes, will rightfully conclude that it is idle to expect you to take any action ca'culated to protect those who have been robbed under the threadbare cloak of a supposed respectability accompanying official listing of a security on the New York Stock Exchange.

I regret that you have seen fit to ignore the plain rules of justice, but confess it was nothing more or less than was expected by me or by those associated with me. I am leaving in a few days for a month's trip to the West and trust that I shall not again be treated with the unfairness which characterized your conduct in this matter during my previous absence from the city.

ANSWERS TO CORRESPONDENTS

Mines and Methods receives a great many inquiries concerning mining propositions and requests for advice or enlightenment on various matters during each month. Some of these require personal replies, while others might just as well and with all propriety be made public. Therefore, readers of this publication who ask questions and seek information that can just as well be handled in this department, will find their answers here.—Editor.

New York, May 29.

I have just been going through the handsomely printed annual report of the Utah Copper Company. In the large photographic presentation of the steam shovel workings above the deep hole in the foreground it looks to me as though some of the numerous grades or banks on which steam-shoveling has been done were caved and that these grades or levels had been restored by the help of brush or pen or in "retouching" the negative. Do you believe that such is the case, and if so, why was it done?

E. M. J.

Mines and Methods has repeatedly told of the loss of steam-shovel benches by caving of the precipitous mountain side and the wrecking of steam shovels. A picture that did not cover up such palpable marks of managerial folly would have no place in an annual report designed to impress the shareholders and the public with the belief that criticism of this method of mining at the property was vicious and unjustifiable.

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Boston, June 3.

It was a great surprise to me to learn through your publication that D. C. Jackling was retiring as general manager of the companies with which he has been so prominently identified. Your criticisms of his policies and abilities I have always felt sure would eventually be shown as unworthy, unjust and uncalled for; now I don't know what to think. Did he retire voluntarily, or was he asked to resign? Wm. McA.

We dislike to encroach upon the legitimate prerogatives of others and would therefore suggest that our Boston correspondent fire his query to the Boston News Bureau, or the Boston Commercial, either one of which we are sure—while they have studiously avoided saying a word about it—can tell precisely why the candle snuffer was dropped over the spot light in which Mr. Jackling's brilliancy has been intensified so long If neither of these publications are footfree enough to tell you call on us again and we shall be pleased to advise you.

Salt Lake, June 11.

According to one of the local dai papers Hayden, Stone & Co., in their notification to Alaska Gold Mines stock subscribers that the second payment of $5 a share will be due July 1, state that on the surrender of receipts for the first $5 paid and a check for the other five, "elaborately engraved stock certificates" will be issued. What do you suppose was the object in referring to the certificates as being "elaborately engraved?" —Subscriber.

Our idea is that the intention was to impress on the subscriber the fact that it was not the purpose to take his $10 without giving ANYTHING of value in return.

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New York, June 16.

The word is being passed along here that a tremendously rich strike has been made in the Alaska Gold Mines Company's property. It is said that sixty feet of $4 ore is being rapidly developed and that the news is being reserved for release upon the return of Vice-President Jackling who is now said to be on his way to the property. Do you think we are getting the right tip? —E. E. & Co.

That such a report may be released upon the return of Mr. Jackling we have no reason to question. Alaska Gold is being touted by insiders as "the best thing we ever had"—and maybe it is, but that would not be much of a recommendation for it as an investment. And if you think you can speculate in it and get away without burning your fingers, just try it. "Startling disclosures" ought to be made with systematic regularity at the Alaska Gold mines from now on and the original 50,000,000 tons of $1.50 ore ought easily to expand to 200,000,000 tons of $3 ore within a year and to 600,000,000 tons of $5 ore within two or three years. It will have to do that well if it outshines the records of the low-grade porphyries promoted by the same community of interests—and we understand the mountains back of Juneau are large enough to supply a limitless tonnage of rock more or less valueless.

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In its review of April operations at the Utah Copper Company's property the Boston Financial News had this illuminating comment to make: "Some rather significant results have recently been obtained in the retreatment of the low-grade concentrates by a flotation process based on that in operation at the Butte & Superior. In case further experiments prove satisfactory, the management believes that by means of this process it will be possible to affect a saving of from $250,000 to $500,000 annually in smelting charges." The Utah company's troubles in this respect were fully ventilated in last month's issue of Mines and Methods; previous to that time there was nothing in the published reports of the Utah company to create the slightest suspicion on the part of the public that there was anything wrong with the grade of concentrates produced at the company's "most perfect" milling plants. But the company's milling troubles are not the only ones, as was clearly shown last month. The property holdings of the company are running mighty short of the kind of ores that will produce a profitable concentrate under the long-term contract entered into with the Guggenheims and, while it is commendable that the present management should seek a means of doing better mill work, it is certain that the original blunder of falling into the smelting contract trap can not be counteracted through anything but a repudiation of that contract, and whilst the Guggenheims are the heaviest holders of Utah Copper shares, and in full control, it is not to be expected that they will relinquish the stranglehold which their smelting contract gives them over the much greater, but scattering, interests in the Utah Copper Company.

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A news item from New York early in the month stated that the $15,000,000 convertible bond issue of the Guggenheims' Chile Copper Company had been "privately subscribed." In other words, the public declined to bite. Verily, the name of Guggenheim has lost its magic.

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It is said that Mr. D. C. Jackling is to go on the board of the General Petroleum Company; presumably Hayden, Stone & Company have been enlisted in the campaign for financing this rapidly growing newcomer among California oil companies.—Mining and Scientific Press, June 21.

How the mighty have fallen.

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The mineral nemalite is a fibrous variety of bucite, a hydrate of magnesium. It is translucent and occurs in slender fibres, which are elastic and easily separated. Its color is white, with a tinge of yellow. It has a silky lustre.

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If diamond-drill rods are greased with melted tallow or other suitable lubricant and then coated with Stockholm tar, it will be found that the tar will make a smooth lining in the hole which tends to prevent caving, says W. H. Trewartha-James (Bull. No. 95. I. M. M.). In some cases, particularly where there is sulphur in the strata, the casing thus formed is almost as hard as cement.

Formation And Growth Of Disseminated Copper Deposits (II)

By JAMES O. CLIFFORD.

In considering the structural relations of the rock series of a disseminated low-grade copper deposit it is pertinent to observe, as outlined in a previous paper, that two conditions are primarily essential; that is, the original mineralization generally is coextensive with areas of igneous intrusive rocks, or the metamorphic derivatives thereof, and that in order to afford an opportunity for the processes of enrichment to be carried out the mineralized area must necessarily be exposed to weathering agencies. Whether we consider a condition of absolute localization or of uniform dissemination of the original ore deposition matters little, as the ultimate result in the matter of secondary mineralization by enrichment will be the same, or nearly so. Thus, if we assume the original mineralization to have resulted in the formation of localized ore deposits of copper as replacements in the overlying sediments, as contact-metamorphic deposits, or as fissures—a condition which naturally would occasion an impoverishment of the mineral content of the magmatic mass as a whole—or whether the intrusive mineral-bearing mass retained its content as a uniform dissemination of original ore, the ultimate result in the matter of secondary enrichment would return the same result. This condition perhaps is best illustrated from the fact that the quantity of mineral carried to the surface by the magma would be definite, and the question then would be one merely of the mode of distribution at the time of original mineralization, dependent, of course, upon the physical and chemical conditions obtaining during the period of intrusion relatively to the rock composition.

GENERAL STRUCTURAL RELATIONS

The general structure of the so-called porphyries seems to follow a well-defined line in that they represent a condition wherein the over-lying rock series (generally sedimentaries) were domed up through the intrusion of acid or basic igneous rocks, resulting in the mineralization of the rock mass either as localized or disseminated ore-bodies, or as a composite of both. Types of both completely localized and of thoroughly diseminated deposits are common throughout the world, and it is not infrequent that they show evidence of the composite condition. However, in view of the circumstances surrounding the period of original mineralization as evidenced in numerous cases, the general condition seems to have been a localization of ore deposits with fractional dissemination, rather than the converse. This is true particularly where remnants of the overlying sediments containing ore deposits of the replacement type have been partially preserved, plainly evidencing a condition of impoverishment of the underlying intrusive responsible for the mineralization.

In many instances, due to the absence of the complete rock series, the assumption naturally obtains that the original mineralization represents a complete dissemination of mineral through the agency of the igneous rock, whereas, in fact, such a condition did not exist, but through later adjustment of the igneous rock affording channels for the percolating solutions, enrichment was brought about in a manner simulating complete dissemination.

For this reason it seems inadvisable to consider the "porphyries" under a common classification as disseminated deposits because the factor of original deposition should take precedence rather than subsequent, or secondary mineralization. It would seem that, under the circumstances, there is no direct law of rock classification, and while selective association (in which each mineral prefers or tends to occur in certain rocks rather than in others) is now a thoroughly recognized law, the more plausible view seems to be that the metal follows its own law of segregation rather than that of the rock segregation. It follows, therefore, that the occurrence of copper mineral as a dissemination in monzonites and quartz porphyries is directly not a criterion governing its absolute genesis, but rather a condition obtaining due entirely to the position of the rock series in any particular deposit relatively to the original mineralization of the superincumbent areas.

In any event, and considering the theory as advanced at present, the essential conditions necessary to the formation of zones of secondary enrichment as a disseminated deposit are strong faults and minute fracturing of the intrusive igneous rock across all horizons, resulting in the formation of zones of complete brecciation. The occurrence of large and well-defined fissures plays a very important role as evidenced in the formation of zones of secondary enrichment in unusual development. These conditions may have occurred at the time of original mineralization, or at a later period through adjustment of the rock mass, but in either event the ultimate result, insofar as enrichment is concerned, will be the same.

LOCALIZATION OF ENRICHMENT.

Synclinal folds play a most important part in connection with downward enrichment of disseminated ore deposits relatively to the condition of mineralization wherein the anticlinal fold represents the original deposition, inasmuch as the side of the basin problem considers the transportation of minerals in solution from the upper area to a lower horizon. For example, we may consider a condition very common among the porphyries wherein the sedimentaries were domed up by a granodiorite intrusion resulting in mineralization, as hereinbefore mentioned. Then through subsequent degradation of the upper exposed area its contained mineral was subjected to weathering resulting in complete oxidation and transportation (in solution) to a lower horizon, the process being continued till the original intrusive rock was itself exposed and subjected to the same treatment. Dependent upon the extent of faulting, fissuring and brecciation of the rock mass, enrichment would follow the line of least resistance.

In the absence of strong faults and strong fissures, but under a condition of complete minute fracturing, the natural result of enrichment would be the confinement of the descending solutions in part to a definite area resulting in the formation of a uniformly disseminated deposit. On the other hand, in the presence of faults and fissures, the natural tendency of the downward percolating solutions would be to concentrate therein and form localized bodies of secondary enrichment. However, under favorable conditions the drainage lines of the ridge exert considerable influence upon the descending solutions relatively to the respective slopes thereof. Assuming no outlet of magnitude intervening between the top of

the ridge and the two bounding valleys it is pertinent to consider the condition of a concentration of solutions underneath the main drainage line of the basins rather than on the side of the basin; provided, of course, that the topography is sufficiently mature and has had time to permit the concentration of solutions under the central drainage lines, and further, that the copper solutions down the axis of the valley have not been diluted to the point that they will not precipitate in quantities sufficient to produce commercial orebodies.

TOPOGRAPHIC AND CLIMATIC CONDITIONS.

Topographic and climatic conditions are very important factors in the development of a commercially valuable disseminated copper deposit. Extreme youth of an area representative of original mineralization, when accompanied by intensive erosion of the surface, results in a very slow enrichment due to the fact that the necessary processes are not allowed to be completed before the material is removed; consequently, if enrichment is at all evident generally it is confined to the upper horizons and is merely superficial. Ordinary youthful topography, assisted by reasonably vigorous erosion of the surface, affords a better condition, while a thoroughly matured topography results in enrichment under the drainage lines. Influencing factors are changes in topography and general structure of the rock mass through subsequent regional earth movements, and it may happen that after a partial completion of enrichment over a given area that there has been a change which will afford either better or worse conditions relatively thereto.

An essential condition seems to be considerable variation in climate over long intervals of time. Semi-arid to arid climates afford satisfactory conditions under certain circumstances. Wide variation of temperature and sufficient moisture accompanied by relatively high temperatures accelerate decomposition of the exposed surface. In this connection it is pertinent to observe that these conditions are the more nearly met in the semi-arid or arid regions than elsewhere, chiefly at altitudes ranging from 4,000 feet and upward above sea level.

PHYSICAL AND CHEMICAL CONDITIONS.

Rock composition generally is the controlling factor governing secondary sulphide enrichment. Dependent upon the power of resistance to physical disintegration orebodies will be formed relatively to the structural conditions surrounding the rock mass. If the intrusive igneous rock, or its metamorphic derivatives, present a compact, unyielding mass not readily amenable to the weathering agencies, it is not likely that enrichment will extend to any great depth; in fact, there will be little or no change in the original mineralization as represented therein. On the other hand, where the rock mass presents a physical structure susceptible to disintegration through weathering processes the condition then is conducive to the formation of secondary sulphide deposits. This is best illustrated, perhaps, by the fact that, where the composition of a rock mass of original mineralization is such that it is subjected to physical disintegration and chemical alteration by exposure to weathering agencies, the exposed portion containing original minerals will be thoroughly oxidized and the copper mineral content thereof in part carried to a lower horizon as an enrichment product, leaving a leached zone of barren capping on the surface proportionate to the intensity of oxidation.

Where conditions are favorable, and the original mineralization carried a relatively high iron pyrite content, it is not unusual to note outcrops of leached areas of capping, or barren rock, composed chiefly of impure hematite representative of the superficial alteration of the exposed surface of the mineral deposit. Generally the more hematite the capping shows, the more iron sulphide will be found in the fresh ore at a lower horizon. Often the residual products of pyrite oxidation are carried by surface waters into adjoining porous rocks impregnating them to the extent that they simulate the original leached area. It follows, therefore, that the apparent area of superficial alteration represented by the iron capping does not indicate the existence thereunder of an enriched zone, only as referred to the original copper mineral content of the mass relatively to the structural conditions obtaining.

Altered areas represented by iron capping do not invariably indicate zones of copper sulphide enrichment, nor is it necessary that there be present any iron capping whatever, as many large deposits show merely inconspicuous outcrops of rotted rock. Finally the principal conditions necessary are the mineralization of the original rock mass; the physical structure thereof; topographic and climatic conditions favorable to the complete degradation and transportation by progressive action of the copper minerals in solution to a lower horizon, there to be precipitated either upon leaner pyrite in the formation of workable bodies of secondary sulphide enrichment, or else, in the absence of primary pyrite, as secondary carbonates and silicates.

GENERAL CHEMICAL PROCESS.

The oxidation of a deposit of sulphide ores is practically the same regardless of the form or character of the deposit. The solution of the sulphides generally is in the nature of sulphates, resulting in the precipitation of the metals at a lower horizon in the form of secondary sulphides. The reduction of the sulphates to metallic sulphides may be accomplished by several different processes, but most frequently by carbonaceous matter, precipitation by hydrogen sulphide, or the reaction of the metallic salts with the unoxidized sulphides below water level; in which event the latter go into solution as sulphates (or other salts), the former precipitating as sulphides.

The first reaction considers that of the oxidation of the original sulphides. Aside from the exposure thereof to the action of atmospheric oxygen and moisture, strong oxidizing agents, such as ferric salts, play an important role. Relative resistance to oxidation and solution is an important contributing factor, and it may happen that chemical action is slower than the physical in which event the partially decomposed original product might be carried away before its contained copper content has been thoroughly leached and carried downward. Further, the chemical and physical composition of the gangue minerals may be such as to make them exclusively the determining factors.

IRON SULPHIDE A FACTOR.

Where pyrite is the predominating sulphide of the original mineralization its products of oxidation are particularly essential as reagents in the enrichment process. There are several ways by which reduction of the pyrite to ferrous sulphate is accomplished: (a), by oxidation solely by atmospheric oxygen, resulting in the formation of ferrous sulphate and free sulphur; (b), reduction to ferrous sulphate, and formation of sulphur dioxide, and (c), a more complete reduction by combined free oxygen and water to the ferrous sulphate and sulphuric acid. In the presence of an excess of sulphuric acid the ferrous sulphate, assisted by free oxygen, results in a further reduction to ferric sulphate. Ferric sulphate, however, is unstable near the surface, but at lower horizons (and assisted by other ferric salts) becomes an active oxidizing solution. Consequently the instability of ferric sulphate near the surface, and the active evaporation attending its presence, results in its forming a product consisting of the various hydrated

oxides of iron. The oxidizing action of ferric sulphate at lower horizons in the presence of water results in its breaking up into two molecules of ferrous sulphate, one of sulphuric acid, and a free atom of oxygen to attack oxidizable substances.

Considering the chemical changes that would take place when copper sulphate comes into contact with iron sulphide, the copper sulphate is reduced to cupric sulphide with the formation of ferric sulphate and the liberation of free sulphur, the ferric sulphate would in turn easily be reduced by hydrogen sulphide or free sulphur. The presence of hydrogen sulphide, resulting from the attack of free sulphuric acid on pyrite would result in the formation of the cuprous sulphide. However, in the direct formation of cuprous sulphide from an assumed solution of copper sulphate it probably would be more reasonable to consider the reactions as obtaining only between copper sulphate, iron sulphide and water; in which event a direct reduction to cuprous sulphide would be brought about with the formation of ferrous sulphate and sulphuric acid with no liberation of free sulphur. The exact chemical reactions governing secondary enrichment will never be written, but some light may be shed on the subject by means of the results obtained in laboratory experiments.

Little attention has been given the subject of the important influence of sphalerite as an active mineral constituent in the chemical reactions governing sulphide enrichment. That it plays a very important role in the case of many of the "porphyries" is well known, but investigations have not been sufficiently thorough to afford much data on the subject.

While thus far we have considered only the relative reactions between metallic sulphides, if we assume the solutions of the original leached area to have been copper bicarbonate instead of copper sulphate results will be obtained wherein the iron will form as a carbonate in lieu of sulphate. However, if the downward percolating solutions carrying copper carbonate do not encounter sulphide precipitants they will not form sulphide deposits at any depth. In consideration of this it will readily be appreciated that the chemical reactions governing the process may be acid, basic, or neutral and as there is no fixed rule in connection with the formation of downward sulphide enrichment deposits other than that above outlined each individual deposit must be considered independently.

Sand Filling As Support Of Mine Workings

By Al H. MARTIN.

The extraction of pillars of rich ore, and permanent support of the old workings, has been a problem for most mine managers from the days of comprehensive lode mining. The most general practice has been the close timbering of heavy ground with expensive timbers, but this has prevented in most instances the subsequent mining of portions of the ground, and compelled the management to abandon numerous pillars of rich quartz, as the timbers have needed the support of the column of rock to sustain the tremendous weight of the hanging-wall. Not only has the adequate support of the underground workings compelled the constant attention of the manager during the active life of the property, but even after the passing of its productive period, because of surface disturbances. The subsidence of the old mine workings has often endangered portions of towns and cities, and legislation has been frequently threatened against the mine owners to prevent trouble of this character.

The finest grade of timber is certain to weaken and collapse under the crushing strain of millions of tons of settling earth in the course of years even when supporting pillars are permitted to carry the greater portion of the strain. In many of the Rand mines, and numerous American properties, it has been found that the ore pillars show decided signs of crushing after carrying the prodigious weight for some years, even with the reinforcement of close sets of timbers. This is particularly marked when the vein-system has a fairly steep dip. Various expedients have been proposed to overcome the problem, and in several instances efforts have been made at its solution by employment of steel timbers, and reinforced concrete supports. Objections to such practices have developed, but the method has generally proved satisfactory when compared with old-time provisions.

It has fittingly remained for the great Rand mining field of the Transvaal to devise and perfect a method at once satisfactory and inexpensive—a method that has so convincingly demonstrated its merit that its use is becoming general throughout the greatest gold field of the world. On the Rand mining is conducted on a stupendous scale hardly appreciated in other fields, and the question of adequately supporting the mine workings at low costs has developed into a vital consideration. Practically all the premier companies have devoted special attention to the subject and after years of systematical experiments sand-filling has been selected as the ideal solution of the vexing question. The employment of the method has been particularly marked during the past two years, and its use is making rapid advances throughout the entire field. The success of the experiment on the Rand has claimed some attention from American operators, but is deserving of a better reception than has been generally extended it on this side of the hemisphere. American mine managers are proverbially slow to adopt the practices developed in foreign fields, which may account for the apparent indifference accorded the method developed by the Transvaal operators.

One of the most successful of the sand-filling plants on the Rand is that operated by the Witwatersrand Deep, Ltd., which has been in commission about eight months. The plant was designed after the method had been thoroughly tried out by several other operators, and embodies all the good features of earlier installations, together with many original improvements of merit. The mill of this company crushes about 38,000 tons of ore per month and 60 per cent of the reduced product is sand, or approximately 22 000 tons. All of this is turned back into the mine for filling of the old stopes and other workings. The Witwatersrand Deep claims are traversed by the great East Rand dike which practically cuts the property into north and south sections. In both portions of the mine sand-filling is proceeding, and not only has it facilitated removal of the rich pillars hitherto employed as supporting agents, but also enables the operators to mine large areas of ground formerly inaccessible under ordinary working conditions. The sand is sent from the surface into the northern portion of the mine through a hole bored for the purpose, and the south section is supplied by way of a winze.

METHODS EMPLOYED ON THE RAND.

At the receiving terminals are placed rows of tanks commanding belt-conveyors. These deliver the product of two

sludge pumps where the sand is mixed with about four times its own weight of water. In this state it is too wet for direct loading into the workings and first passes to the dewatering station where six Caldecot dewatering cones, for each station, reduces the moisture to about 28 per cent. The amount of water to be used forms an important point, and varies somewhat in different properties because of natural conditions. Without a sufficient percentage of water the sand cannot be effectively delivered to the various portions of the mine, and if the amount of water is excessive it must be pumped out again. The quantity used at the Witwatersrand was decided on after a comprehensive series of tests, and has proven satisfactory in this particular instance. The cost attending surface handling of the sands are approximately the same as are entailed in dumping the residue, while underground costs are slightly over four cents per ton. It is thus readily apparent that the process is fairly inexpensive.

As a result of the installation the management states that the safety element has been materially increased, and damage to surface buildings by sliding ground virtually eliminated. It has also enabled the carrying on of operations on a larger scale, inasmuch as more extensive areas of ground may be worked at once without danger of caving. Besides it permits the extraction of columns of commercial quartz formerly left to aid the timbers in sustaining the weight of the hanging-wall. In the old workings of this property several of the pillars show signs of yielding to the excessive strain, and sand-filling has proven far superior to timbers in assisting the pillars in bearing the load, when it is not deemed advisable to extract the supporting columns. The operation of the sand-filling plant is practically automatic throughout, and requires little attention, save at the surface loading stations and points of application.

An earlier and likewise successful sand-filling plant is operated by the Cinderella Consolidated, one of the greatest of all Rand companies. To gain an adequate idea of the extent to which sand-filling has progressed on the Rand, and the extensive manner in which it is being utilized, a brief description of the Cinderella Cons. is appropriate The mine embraces 2,100 claims in the East Rand section of the Main Reef field, with the holdings coursing along the strike of the reef for from 16,000 to 17,000 feet. The present main working shaft has an incline depth of over 7,100 feet. The company is sinking a new main shaft, the Central, which in many respects will be one of the most remarkable working avenues in any mining property in all the world. It has seven compartments, with inside dimensions of six by forty-two feet and will be eventually sent to a depth far exceeding the point attained by the old shaft.

The orebodies are of great size and carry usual Rand values, and late reports indicate an ore reserve considerably in excess of 750,000 tons. The reduction facilities consist of 100 1,650-pound stamps, three tube-mills and a comprehensive cyanide plant, giving a capacity of 22,000 tons per month. The company has experienced considerable loss and annoyance by so-called "air-blasts," the result of violent fractures and earth movements, a condition frequently attending operations in deep mines. The terriffic pressure of the superincumbent strata at such depths crushes down stopes and other workings, and the ground fracturing under the enormous pressure bears down timbers, supporting pillars and other sustaining devices. The rush of air naturally following the collapse of the workings gives the name to the "air-blast." In the deep mines of the Rand such an occurrence is not infrequent, and the Cinderella Consolidated temporarily lost three of its richest stopes in this manner less than a year ago.

CINDERELLA'S PRACTICAL SCHEME

The filling of Cinderalla Consolidated workings with sand is carried on through a wooden box launder, having inside dimensions of 11x12 inches, and carrying the sand to a total vertical depth of 3,900 feet when so desired. As the greatest strain from earth pressure is experienced at considerable depth, it is readily apparent that sand-filling is most frequently conducted in the bottom levels. The sand from the surface bins is delivered to the launder by a belt-conveyor, which replaces, the pipes and launder formerly employed for this purpose. The sand passes in a dry state to the launder, as tests demonstrated that when the sand contained more than four per cent of moisture it clung to the sides of the launder and speedily checked the flow of the material to the deep levels. The falling sand drops upon a sharply-inclined plate of iron, upon which a stream of water is directed. This forms a mixture which flows into a steeply pitched launder where the sand and water are more closely associated before passing to the pipes and launders which deliver the sand to the portions of the mine undergoing filling. The speed with which the filling is conducted, and the efficiency of the plant, depends largely on the amount of water constantly available for sluicing the mixture into the filling pipes and launders, as the delivery of sand from the surface bins to the shaft levels proceeds rapidly as long as the material is kept dry. In this state the sand drops freely down the box launder without touching the greater area of the box, but when the percentage of moisture exceeds five annoying consequences develop. A slight excess of moisture does not cause trouble provided the sides of the box are dry, but when seven per cent and upwards of water are present the sand adheres to the box, and its fall is naturally impeded. As the ratio of moisture increases the descent of the sand becomes correspondingly affected. It is for this reason that the sand should be relatively dry before using.

Attempts were at first made at the Cinderella Consolidated to overcome the clinging tendencies of the damp sand and increase its velocity by means of compressed air, but after repeated trials the attempt was abandoned as valueless. Another plan was the placement of a blower at top of launder, and establishing connections near the bottom with the intake of a ventilating fan, but this also was found impracticable, and the only satisfactory method proved the handling of a dry product.

Aside from the advantage derived by the employment of sand for filling, there is the additional one of reducing the amount of water to be pumped from a mine of average wetness. The sand sent into the Cinderella Consolidated has a moisture of three per cent and it is estimated that about 8,000 gallons of water are used in the mine each day in connection with the sand-filling work. Under other conditions it would be necessary to elevate this water 4,000 feet, consequently the employment of the practice lowers the pumping costs to a fair extent. The filling is in charge of an expert timberman, but the other work is performed by native and unskilled white labor. Total costs approximate five cents per ton for underground work.

The Cinderella Consolidated method differs considerably from the one employed at the Witwatersrand Deep, as readily appears upon examination. By the use of its apparatus the Cinderella Consolidated avoids the use of dewatering machines, but is under the necessity of maintaining an exceptionally dry product on surface. The method is favored by many Rand companies when continuous filling is not required, otherwise wet weather would greatly diminish its efficiency by making the sand too damp for rapid work. The simplicity of the Cinderella Consolidated

method is its strongest recommendation, aside from the excellent results obtained under favorable working conditions.

In using the Cinderella Consolidated method it is recommended that the sand contain not more than three to six per cent of moisture. Because of this it is inexpedient to use the sands direct from tanks, and the material should be exposed to the action of sun and air at least two days before using. This not only reduces the moisture sufficiently, but also neutralizes the cyanide or destroys its powers. Attempts were at first made by the inventors of this method to neutralize the cyanide with potassium permanganate, but it was found that the treated product when brought into contact with the ordinary acid mine water developed cyanogen gas. The presence of this terribly poisonous element in a mine must naturally be prevented, and it has been found best to expose the sand to the sun and air several days.

The box launder was adopted after several tests with iron pipes, and its success has been convincingly proven. It was originally intended to mix the sand and water on surface, the usual practice, and send the mixture down the shaft, but the excessive wear of the pipes, largely because of the great depth to which the product was carried, led to the contriving of the present method. The box launder should be placed in the driest of the shaft compartments on the down-cast side, and the outside tarred if sand containing as high as nine per cent water is used.

An exhaustive series of tests carried on by the Cinderella people conclusively proved that sand containing ten per cent and upward of water could not be advantageously used, because of the impossibility of keeping the launder free of the clinging material. Whenever the launder becomes choked with sand a stream of water is used to sluice it out. The ever present possibility of such an occurrence makes it essential that a dependable bell-signal service, or similar arrangement be maintained between the surface bins and the filling point, also that an ample water supply be constantly available for the clearing of the choked launder.

The rate at which the sand should be supplied depends to some extent on the experience of the labor, for it must not be fed too swiftly or it develops a tendency to crowd the bottom sections of the box, while it must be delivered at a sufficient speed to insure a good velocity. At the Cinderella Consolidated the launder is provided with observation doors at every 100 feet, enabling the operators to readily detect cause of any troubles that may develop. With sufficient water for sluicing and the sand fairly dry, there is little trouble in maintaining a satisfactory flow of the sand.

The process employed by the Witwatersrand Deep Co. is the one most generally favored by Rand operators, and may be considered a standard method of sand-filling. The sand is taken direct from the tanks, and the free cyanide neutralized by feeding potassium permanganate into the pulp. Tests of the treated product are made regularly to detect any trace of free cyanide and prevent its passage into the mine workings. It is essential that the sand used in filling be sufficiently moist to pack well, as a too dry product is more difficult to handle and flows through the supplying pipes and launders less readily. Yet the product must not be too moist, or the necessity of pumping out the excess water means loss of time and added expense.

While the management of the Witwatersrand Deep uses an admixture of seventy-two parts sand and twenty-eight parts water, the property is an exceedingly wet mine and the use of a very moist sand is carefully guarded against. The company is pumping about 1,500,000 gallons per day at present, and a few months ago was handling 2,000,000 gallons. The excessive wetness of this mine is attributed to the big transverse dike which cuts through a portion of the Witwatersrand Deep and neighboring properties. Within a short time it is expected the powerful new pumping system of the East Rand Proprietary company will relieve the Witwatersrand Deep of a considerable portion of the water, in which event it is possible the proportion of water used in the sand filling will be increased.

SAND FILLING SPELLS MINE SAFETY.

In many of the dry mines of America it probably would be found desirable to employ a mixture containing considerably more water to insure best results. Sand-filling may be carried on very much as ordinary timbering, as the timberman in charge of the work completes the placement of the sand in the workings as the ore is removed. In this way there is no necessity for leaving large open chambers unsupported for any length of time, and caves or movements of ground toward the shafts, are effectively controlled. The total costs of sand filling on the Rand varies from ten to twenty-four cents per ton, including surface handling. It costs about ten cents per ton to handle the sands from the tanks and store on the dumps in ordinary practice. It is thus apparent that the sand can be sent down to the mine levels almost as cheaply as it can be stored on surface.

The danger of caves in deep mines, and resultant airblasts of terrific severity, is intensified by the room and pillar method of mining and similar practices, and it is under such conditions that the use of sand for filling of the old working claims particular attention. The pillar and room method means large open spaces, and a large open stope is a source of positive danger. In many mines worked by this method the men labor under cover, the guarding pillars protecting them from sudden caves of the hanging-wall. The pillars are subsequently removed by top-slicing. But there is always the possibility of the ground crushing down the supports, unless a large number of pillars are provided. The method is dependent for success upon the bringing down of the capping evenly and regularly, and it is economically necessary that the maximum quantity of ore be caved down in the shortest possible period of time. The method has been developed along particularly successful lines in the Lake Superior district, and it is notable that airblasts are very common in this region.

As before stated an airblast is caused by intense compression of air in a confined space. The fall of an enormous tonnage of rock into a large empty stope hurls a crushing wave of compressed air through the mine very much as a similar wave is set in action by a gas or dust explosion in a coal mine. The rushing blast of air sweeps timbers, cars and men along with tremendous force, and such blasts have often caused heavy loss of life and considerable property damage. It is not to be concluded that airblasts are always the result of caving methods of mining, for disastrous blasts of this character have frequently occurred in more restricted workings. They were not unknown on the Comstock when that famous lode was at the zenith of its glory, and have developed in most of the deep mining regions of the world.

DESTRUCTIVE FORCE OF AIRBLASTS.

A convincing demonstration of the terrific force of an airblast, and its deadly properties, was recently evidenced at the Miami copper mine, where three men were killed, seven seriously injured, and others hurt in minor ways by the swirling blast of air driven from 245-foot level by the collapsing of capping estimated to comprise 3,000,000 tons. In this mine the men work under protecting pillars, and the falling rock itself caused little damage. But the cave drove the compressed air forth at ter-

rific velocity, carrying death and destruction into the nearby drifts. The resistless nature of the blast was evidenced by the driving of a seven-ton motor and fifteen ore cars along the track for 200 feet, despite the desperate efforts of the motorman to check the terrific force of the rushing wind. In foreign fields the airblast has been a most destructive agent, and the frequent occurrence of such accidents on the Rand was one of the prime reasons for adopting the sand-filling method.

The danger of airblasts has been given little consideration by metal miners in the past, although numerous precautions have been taken to guard against the danger of falling masses of rock. The series of airblasts recently occuring in many districts, however, particularly in deep mines and where large stopes are worked, have awakened managers to the presence of an element of peril that must be guarded against as carefully as other potential sources of danger. It is universally conceded that the most dependable guardian against the airblast is an adequate support of the roof of the underground workings, but conditions are frequently of such a nature that close timbering is economically impracticable. In many districts timbers are difficult to secure, and costly to install, while the margin of profit attendant on mine production is so limited that the management does not feel justified in assuming further expenses.

Under the present exigencies of the commercial era, each mining company is endeavoring to rush production. Practically every progressive manager is striving to extract the largest possible quantity of ore within a specified time, and the earning of maximum profits forms the chief consideration. But such a practice has its draw-backs and penalties, and the insufficient support of heavy ground too often entails subsequent costs and delays.

When the lessons of Rand mining are studied and analyzed, and it is realized that the sand-filling method has only been adopted after years of comprehensive and intelligent trials by the leading Transvaal companies, it seems strange that the practice has not been given greater approval by American operators. The method was not employed by the Rand companies before its merit had been definitely established, and while most managers admit there are many opportunities for improving the system, it has incontestibly saved an immense sum to several operators, and facilitated extraction of ore from sections of ground previously inaccessible. Not only has sand-filling proven of inestimable benefit in protecting the mine from the effects of disastrous caves, but has also increased the important factor of personal safety whenever employed. And the human factor, the adequate protection of the employees, must be considered. Unless the miners know they are working in a fairly safe stope, with all possible precautions exercised to secure them from accidents, they cannot be expected to remain satisfied with conditions, nor to do their best work. No man can give his best, when he knows that danger constantly hovers near. And no man will work for long in a property he knows to be absolutely unsafe. Furthermore, it is the duty of the company to protect its men to the utmost of its ability. And as a means of protection the sand-filled workings have demonstrated their worth. The subject is commencing to claim some attention in America, and has been given a trial in some instances, but has yet to be given the support by the mining fraternity to which Rand results prove it to be entitled.

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ELECTRIC FURNACE SMELTING

Elsewhere in this issue of Mines and Methods there appears an article on the subject of zinc smelting with the electric furnace prepared by Mr. Peter E. Peterson, mining engineer, of Butte, Montana.

It will be of interest to readers of this journal to know that the author conducted his experiments as therein outlined on the Butte and Superior property using, in part, ore and concentrate from that company's mine and concentrator for the purpose. The practicability of the furnace was fully demonstrated.

During the period of experimental operations by Mr. Peterson, and immediately following the inauguration of a new management represented by Utah Copper interests, the announcement was officially made that, in lieu of the treatment of Butte and Superior mine-run ore by established "wet" methods of concentration, a new "dry" process would be installed, which latter would afford a production cost for spelter lower than that obtaining elsewhere in the mining world. The "dry" process mentioned, so we are informed, considered the treatment of the mine-run ore in the electric furnace and the direct production of refined spelter on the property, thereby eliminating the necessity for a preliminary ore-dressing and shipment of concentrate to eastern zinc smelteries for further refining. Though negotiations had been entered into between the management and Mr. Peterson for use of the electric furnace process, later they were declared off. Then followed the "remodeling" of the original efficient concentrating method by installing the "Garfield" system of milling—as outlined in earlier issues of this journal—which in turn was abandoned.

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Ways and means should be devised at every mine, large or small, to determine, at least approximately, what the value of its product is before shipping. Whether this knowledge is gained by actual sampling of the ore in the mine before it is broken, or afterwards, by various methods usually employed, will depend on local conditions.

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Breathing can usually be restored after an electric shock within an hour, says Coal Age. Keep up artificial breathing for this length of time at least After breathing starts, begin to restore the circulation by rubbing the limbs briskly in the direction of the heart and under the covers with which the patient has been previously covered.

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The fire-fly produces light in a very efficient way. The spectrum of the emitted light consists of a narrow band in the yellowish-green portion of the visible rays, apparently unaccompanied by any emissions in the ultra-violet or ultra-red portions. When oxygen is absent no light is given out, and the light is not necessarily connected with the life of the insect. The abdominal material, when dried and powdered, may be kept for two years, and it will then emit light if moistened and exposed to oxygen. As yet chemistry has been unable to duplicate this result.

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Rain-water collected after a long period of wet weather is the most natural water. It contains atmospheric air and gases in the proportion of about 2.5 cubic inches to every 100 cubic inches of water. River water is the next purest, then comes the water of lakes, ponds, ordinary spring and mineral springs. Following these waters comes arms of the ocean lying in the vicinity of the mouth or discharge of great rivers, then follows the water of the main ocean and last of all the waters of lakes, like the Dead Sea, Caspian Sea, and the Salt Lake of Utah. Spring water although perfectly transparent contains more or less mineral matter dissolved in it. The nature of these impurities will depend on the character of the soil through which the water percolates. The most general impurities are carbonate of lime, common salt, sulphate of lime (sometimes called gypsum) sulphate and carbonate of magnesia and compounds of iron Most spring waters contain a certain proportion of carbonic acid gas.

THE ELECTRIC FURNACE FOR SMELTING ZINC ORES

By PETER E. PETERSON.*

From the nature of the present retort method of recovering zinc from zinc concentrates it is almost impossible to conceive of any improvement therein

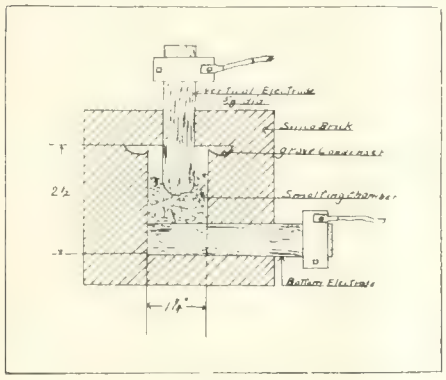

Fig. 1.

that would lead to increased capacity and decreased costs, let alone the possible recovery of zinc from the abundant complex zinc ores (containing copper, gold, silver, lead and iron) at a reasonable cost and appreciable recovery of the other metals.

The metallurgy of zinc is one of distillation. The zinc must be vaporized at a high temperature, and in a reducing atmosphere. Outside of the retorts the electric furnace is the only smelting device that can meet these conditions, and seems to hold out the only hope for improvement in zinc smelting.

The possible apparent advantages are: Large units continuous feed and discharge and the recovery of gold, silver, copper and lead in the form of copper matte or lead bullion.

The problems encountered in building a furnace to make the above advantages a reality have been many, and perhaps much time and work can be saved to others by a discussion on different types of furnaces employed.

THE FIRST FURNACE.

Fig. 1 shows a vertical section of the first furnace experimented with. This furnace had no opening to the outside, although there was some leakage of gas around the upper electrode. The charge consisted of mixture of zinc sulphide, copper sulphide, lead sulphide and iron sulphide, and sufficient metallic iron to desulphurize the zinc sulphide (ZnS+Fe =Zn+ FeS). The furnace was connected to small direct-current generator and run at the rate of 4 kws. per hour, the amperes varying from 40 to 50.

There was no way of telling when the charge was smelted, so a series of runs were made ranging from 1 to 3 hours. At the end of 3 hours the charge was completely smelted. The resulting matte showed from 1 to 2% zinc and small shots of metallic lead, while 95% of zinc in the charge was recovered in form of a high-grade spelter assaying 99.8% zinc. The 3-hour run was repeated and practically the same results obtained. Another furnace was built with a condensing chamber on one side with a small opening for escape of gases. With this furnace it was not possible to condense the zinc to spelter, it being condensed in the form of blue powder.

LARGE FURNACE BUILT.

Results with these small furnaces were so encouraging (and there seemed to be

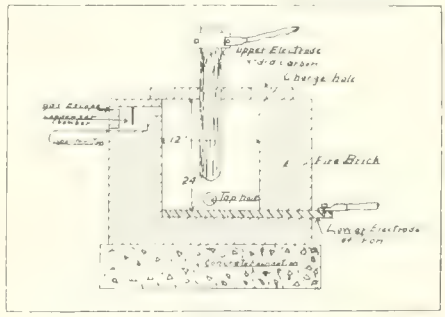

Fig. 2.

no difficulties in condensing the zinc) that a larger furnace was built along the same lines. This furnace was constructed of ordinary fire brick having walls 1 foot thick and a smelting chamber 1 foot square and 2 feet high. The top consisted of slabs of fire brick 2 inches thick with a charge hole and an opening for the electrode. The bottom electrode was a block of iron having a cross-section of 1 inch by 12 inches, extending through the wall and protruding 8 inches. The vertical electrode was a carbon rod 2 inches in diameter and 4 feet long. This furnace had a rectangular condensing chamber 6 by 6 by 12 inches with a baffle running the long way, causing the gases to circulate first down one side and then up the other. There was a small opening ½-inch in diameter at one side of the condenser for the escape of gases. (See Fig. 2).

The furnace charge used consisted of unroasted zinc concentrate analyzing as follows: 47.81% Zn, 9.21 insoluble, 6.2% Fe, 1.5% Mn, 30.32 S, 1.4 Cu, 0.035 oz. Au and 12.2 ozs. Ag. Scrap iron was added to desulphurize the zinc

The power was obtained from 50-kw. alternating transformer. The electrodes were connected to 110 volt circuit, and in series with the circuit was packed a choke coil to protect the transformers in case of short-circuit, and at the same time to somewhat regulate the current.

Numerous runs varying from 4 to 12 hours were made. The condensing arrangement failed to condense anything but blue powder. The furnace consumption was irregular, and consequently the heat was the same. Attempts were made to tap the furnace, but were not very successful, although some slag and matte was tapped which analyzed as follows: Slag—Zn 4%, Cu 0.19%, FeO 11.1%, Au trace, Ag .35 oz. Mn 0.6%, SiO_2 64.65%. Matte—Zn 1.3%, Fe 60.4%, S 29.35%, Au 0.03 oz., Ag 9.4 ozs., Cu 1.70%. The analysis of the slag and matte is interesting and showed the possibilities of the process.

CHANGE IN CONDENSERS.

The furnace was next equipped with a 2-inch iron pipe, 2 feet long, for a condenser. This pipe was flush with inside, and stuck out a foot into the air. With this arrangement it was possible to condense some spelter after an hour's run, which allowed time to heat the condenser up to the condensing temperature. At this stage of the experimenting

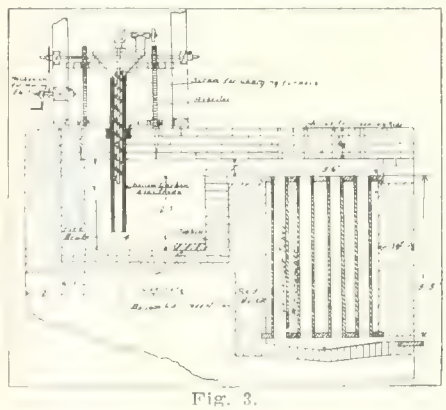

Fig. 3.

it was evident that for successful condensation of volatilized zinc to spelter, there must be some way of controlling the temperature. The next experiment

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consisted of a 2-inch iron pipe 6 feet long, extending across the top of the inside of the furnace with series of holes bored into the upper side of pipe for the admission of zinc vapors, the theory of the apparatus being that with a long pipe,

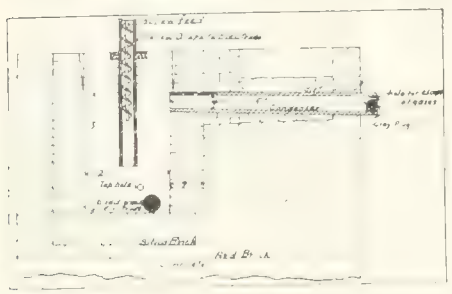

Fig. 4.

one end cold the other hot, between these two temperature extremes there would always be a zone of the proper condensing temperature.

This condenser gave fair results. Starting the furnace cold at the end of an hour, it was noticed that condensing commenced and would continue at a good efficiency for an hour; when the condensers seemed to get too hot, or rather the zone of proper condensing temperature was greatly reduced in area. Various means were tried to increase the length of this condensing zone.

A larger pipe 8-inches in diameter was inclosed with brick and heated with coal. Clay tubes of varying lengths and thickness were tried. Iron pipe insulated with varying thickness of asbestos, and chambers of varying dimension in the wall of the furnace, was experimented with, but none of these gave better results than the 2-inch pipe 6 feet long.

The problem seemed to resolve itself into three parts; that is, a certain temperature was found to be necessary as well as a certain area, and that this area must not be too far away from the source of distillation. In other words, the zinc must not be kept in a vapor form too long before condensing. The furnace seemed to stand up well, except the cover, and this usually did not last more than a couple of days.

FURTHER DEVELOPMENT.

The bottom electrode, although of iron, gave no trouble, which was no doubt due to the shortness of the runs. Up to this time there was no very definite idea of costs, such as electrode and power consumption, so another furnace was built of the same type and an effort made to run a ton of zinc concentrates in one run, keeping careful record of the power and electrode consumption, disregarding entirely the condensing of the zinc to spelter. This run was in two parts, one using metallic iron as a reducing agent and the other using lime and coke, according to the following reaction: $ZnS + CaO + C = Zn + CaS + CO$.

The following results were obtained:

Reducing agent—	Iron	Lime and coke.
Kw-hours consumed	360	388
Pounds ore smelted	650	563
Pounds reducing agent	193	197
Total pounds of charge	648	560
Kw-hour per pound charge	556	692
Kw-hour per pound zinc contrates	79	1.07
Kw-hour per ton zinc concentrates	1580	2140
Kw-hours per ton zinc concen-		
Per cent of zinc extracted obtained by difference	90	50

*164 lbs. lime; 33 lbs. coke.

The above test using iron as a reducing agent, was made in three separate runs, the furnace being allowed to cool down between runs. In using lime and coke the furnace was allowed to cool down four times. Copper coated carbon electrodes, 3 inches in diameter were used, and the carbon consumption per ton of zinc concentrates was 12 lbs. This furnace was lined with magnesite brick. The run did not show them to be superior to fire brick. Under these conditions the cover of the furnace suffered the most and had to be replaced twice. The power consumption varied greatly, and it required constant moving of the electrode by the operator to keep the furnace running. The furnace was charged once an hour by means of hopper with a slide in the bottom. Immediately after charging the zinc vapor issued from the ends of the condenser with great velocity, due to the small amounts of moisture present. The charge was not preheated as it should have been. There was no separation of slag and matte. An analysis of the material tapped from the part of the run using lime and coke for reducing agent is as follows:

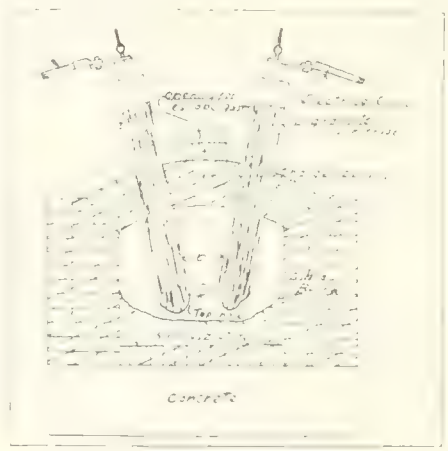

Fig. 5.

In crude	Fe	S	Zn	CaO
Sc	13.2	24.3	24.3	35.1

At this time it was decided that the most economical method of treating zinc concentrates could be attained by roasting them to oxide, but leaving sufficient sulphur to form a matte as a collector for the precious metals. After some experimenting the practicability of the following reaction was proved:

$Fe_2O_3 + 3C + 2ZnS = 2Zn + 2FeS + 3CO$.

By this method the major part of the zinc is reduced from the zinc oxide by carbon, and the zinc in the sulphide form is reduced by iron, which has been reduced by carbon from iron oxide.

THIRD FURNACE BUILT.

The next furnace constructed was to have a capacity of 1 ton of roasted zinc concentrates per day. The furnace was a radical departure from anything previously tried. The charge was fed into the furnace through the upper electrode so as to introduce it directly into the arc. There were eight clay condensing tubes inclosed by heavy brick walls with an arrangement to cool the tubes as rose above the condensing temperature. (Fig. 3 shows drawing of this furnace).

The condensing tubes being inclosed in heavy brick walls, it was thought that in time, about two or three days, the condensers would become over heated from the zinc vapors, and then it was proposed that the tubes be cooled to the right condensing temperature by air. This condensing temperature we were led to believe was between 450 and 515° C. Ingalls' book on Zinc Smelting gives these figures. Later this condensing temperature was determined to be above 864° C. This is also consistent with theory when it is considered that zinc boils under normal conditions at about 920° C.

CONDENSER DIFFICULTY.

After several runs lasting from two to six days it was found impossible to heat the condensers to 450° C. let alone 864°. The zinc was condensed in the form of blue powder as was to be expected.

The brick work in this furnace was put in with all possible care, yet frequent explosions resulted from the leakage of CO gases into the air chamber surrounding the condensers. The openings were continually choking up with blue powder, and it was found rather hard to keep them clean. This character of condensing apparatus was too complicated to offer any success.

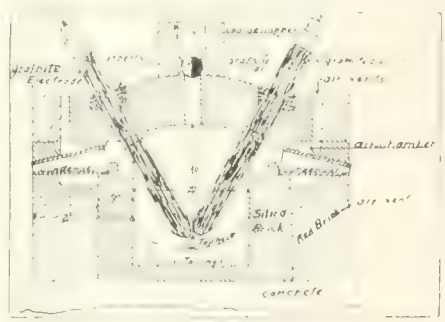

Fig. 6.

The expected improvements in smelting gave considerable trouble. The furnace was connected up without any regulating device to control the power, and as a consequence it was found impossible to keep a constant heat. The charge was intended to be fed continuously through the hollow electrode by a screw, but due to variance of fusing the feed was continuously choking. The object of charging in this manner was to obtain lower power consumption per ton of charge. This was accomplished.

MECHANICAL DIFFICULTIES.

The power consumed was from 1,100 to 1,300 kw.-hours per ton of 50% zinc concentrates, but the mechanical difficulties still existed. The hollow carbons gave considerable trouble by breaking. Later graphite tubes were used which gave better results. The bottom electrode which was of iron, as in the former furnaces, melted and destroyed the bottom of the furnace with it. The furnace cover showed no deterioration whatever.

The furnace was remodeled. (See Fig. 4). In place of the iron electrode in the bottom a 6-inch diameter graphite electrode was substituted. The smelting chamber was reduced in size and a water rheostat was placed in series with the circuit as a means to control the power.

The condensing apparatus was replaced by three clay tubes 1 inch thick, 4 inches inside diameter and 5 feet long. These were placed in a shallow brick chamber open at the top. These condensers were covered with varying thicknesses of dirt, as it was thought necessary to maintain the condensing temperature. With this device some spelter was obtained. From 4 to 5 inches of each tube was doing the condensing, and the greater part of each tube was too cold to condense. The condensing apparatus was next replaced by eight tubes 1 inch thick and 4 inches inside diameter, all of different lengths varying from 14 to 28 inches, two of these tubes were of carbon; the rest were of clay, and two of the clay tubes were partially filled with charcoal.

The ends of these condensers were luted with clay, leaving about 5/8-inch diameter hole for the escape of CO gases and uncondensed zinc vapor. Pyrometers were constantly kept in the tubes. No zinc could be condensed unless the inside surface of the condensers was above 840° C., and at 900° the condensers were too hot. The carbon tubes condensed no better than the clay tubes; the clay tubes containing charcoal did not condense quite as well as tubes without.

At no time during this run was the zinc completely condensed for there was always uncondensed zinc burning at the ends of tubes, and at all times the condensers would condense spelter if the temperature was around 864° C. From these results it was concluded that each of the tubes had a limited condensing capacity, and if the tubes were kept at 864° C., and the amount of zinc volatilized kept within the limits of the condensing capacity of tubes, there would be practically a complete condensation of the zinc.

PRODUCES SPELTER.

Another change was made in the furnace. Solid graphite electrodes 6 inches

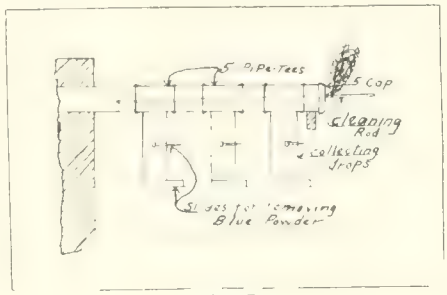

Fig. 7.

in diameter were used in place of the hollow ones, and charge was introduced by means of a screw through one side and near the top of the smelting chamber. The furnace was run on barren charge until the condensers attained a temperature of 859° C., then a charge containing zinc was introduced and fed at a rate so that very little zinc appeared in the flames burning at the ends of the condensers. This maintained for 12 hours and the spelter condensed and recovered was 86.4% of the amount charged into the furnace. Thus at last

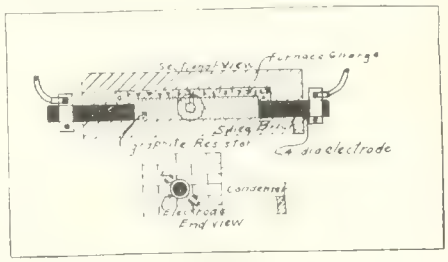

Fig. 8.

it was proved that spelter could be made with the electric furnace but it was observed that the power consumption was approximately 4,000 kw.-hours per ton of 50% zinc concentrates.

The furnace bottom was giving trouble; it melted out almost as readily as the charge. This complicated matters making slag thick and pasty, and only occasionally did any matte appear with the slag, but the matte was always found when a furnace was torn down. The bottom electrode was consumed at about the same rate as the vertical one. This and other reasons made the furnace exceedingly hard to control. The destruction of the furnace bottom was attributed to the arrangement of the electrodes.

The condensation of zinc requires constant conditions, each as a quite uniform flow of gases, and a constant heat which could be easily varied. The next step was to improve the smelting part. A small furnace was erected with two electrodes through the top. (See Fig. 5.) These were placed about 6 inches apart. The inside of the furnace was lined with silica brick and the bottom covered 10 inches deep with siliceous zinc tailings from mill jigs. No efforts were made at the condensation of spelter, the zinc fumes passing into a flue and allowed to go to waste.

With this furnace numerous runs were made covering a period of 30 days. Slags of different composition were tried and the proportion of reducing carbon was determined. This work resulted in much useful information concerning furnace charges. We had no difficulty whatever in making slag and mattes and tapping them from the furnace, and the power or heat could be kept constant or varied at will with practically no attention. Test runs on recovery of metals and power and electrode consumption were very satisfactory. The furnace was torn down and showed practically no deterioration whatever, in fact part of the tailings from the furnace bottom were not altered.

CONICAL CONDENSERS.

A larger furnace was constructed along these lines fitted with eight conical condensers, such as used by the zinc smelters in Kansas and Oklahoma. A run was started and for the first 24 hours was encouraging. Then the old trouble returned. The furnace would not respond to regulation and no slag could be tapped. The apparent electrode consumption was enormous; 20 feet of 6-inch diameter solid graphite electrodes were fed into the furnace in six days time. Something was radically wrong, and on opening the furnace it was found that a hole 6 feet below the bottom had been melted out. The electrode consumption had been very little, the electrodes when removed were 12 and 14 feet long respectively. The trouble was caused by the arrangement of the electrodes. The operators in attempting to regulate the power had lowered the electrodes through the bottom of the furnace.

The hole in the bottom of the furnace was filled with siliceous zinc tailings, and the electrodes placed at such an angle ot each other (see Fig. 6), that when lowered they would meet at the bottom of the smelting chamber. The screw feed was abandoned owing to the irregularity of air supply used in run-

ning in, and charging of the furnace was accomplished by means of a brick hopper with a graphite electrode for a slide in the bottom.

The furnace as now arranged was smelting during actual running time for thirty days with five stops, during which time the furnace was allowed to get cold. During these runs the previous condensing experiences were repeated without any improvement. The spelter that was condensed was found remarkably pure, assaying from 99.3 to 99.8% zinc. The furnace gave no trouble in any way. Slag and matte were tapped every twelve hours.

For the time being the efforts at improving the condensers were abandoned and arrangements were made to recover all zinc products. To accomplish this a new furnace was built, and special iron condensers were made to recover the blue powder; also a bag house was used to catch the zinc oxide in fumes. (Fig. 7 shows view of blue powder condenser.) A 12-day run was made without difficulties of any kind. The charge was fed in every hour, and slag and matte tapped every twelve hours. The metallurgical results will appear in another article.

This furnace in its present improved form is about all that can be expected of any furnace. There are far less difficulties encountered than in running an ordinary blast furnace.

The deterioration of the furnace is small. Such a furnace should run from six months to a year without any extensive repairs. Large units can be constructed by merely the addition of more electrodes, and there is no reason why units of twenty-five to fifty tons each could not be operated as easily and cheaply as the one-ton units.

In connection with the condensing experiments a small register type of furnace was constructed. (See Fig. 8.) This furnace was made with a view to duplicating the conditions existing in the present day zinc retort, with the exception that electrical heat was used instead of gas or coal.

The essential parts of the furnace were a rectangular brick chamber having a resister of graphite blocks in the bottom, connected to an electrode at each end. The arrangement of this furnace was such that the heat was always under control. There was one condenser of the same type as used in retort smelting. The furnace was charged intermittently with roasted zinc concentrates and coke and coal.

In operating this furnace great care was taken in regulation of the heat so as to have the same conditions as in the retorts. It was noticed that the zinc began to volatilize before the condensers were hot enough to condense it to spelter, and that after the condensers had reached the right temperature, there was more zinc volatilized than it would condense, and when the heat was reduced to cut down the volume of zinc vapor, the condenser would get too cold. This condenser when at the right temperature which could be easily maintained, would condense two pounds of spelter per hour with approximately the same amount of zinc vapor passing through without condensing. There could be no doubt whatever as to the gases being of the same composition as in the retort.

These experiments were repeated a number of times, and the results were always the same. And to me they prove conclusively that the failure to condense zinc to spelter in the electric furnace is due to the difficulties in maintaining sufficient condensing area at the right temperature near the source of volatilization.

In another article will be described a condenser designed to meet these difficulties.

MICROSCOPY IN ECONOMIC GEOLOGY

By R. BECK.*

The great advances which have been made in the systematic and genetic knowledge of minerals and rocks since the application of the microscopic method of investigation are well known. So numerous are these results that they can hardly be comprehended. But a limit has already been reached, beyond which a fruitful development of the science through this means alone is scarcely to be expected. After a surprising number of unlooked for constituents were shown to be present in the rocks and thereby entirely new points of view had been opened up to systematics, the investigation of the structure or the manner of intergrowth of the constituent minerals of rocks was brought into the foreground, and attempts were made to draw important genetic conclusions from these results. It was found, however, that the bulk chemical composition of rocks, which had fallen into comparative neglect after the introduction of the microscope, as contrasted with the preceding period of the hand lens, was a significant genetic factor. Chemical analysis was therefore again established on a new basis, and its results successfully applied to genetic classification. But even then the goal was not attained. Experimentation, especially fusion in the electric problems, began to attain general importance in modern petrography. But here also the microscope is necessary; for by means of it thin sections of the natural occurrences are compared with sections obtained from artificial melts. It is evident that in this field petrography frequently comes in contact with metallurgy and especially with metallography.

EARLY PETROGRAPHERS NEGLECTED OPAQUE MINERALS.

Along the path of development which has just been sketched, petrography on the whole bothered itself but little with economic geology. The petrographers of the '70s and later, for example, treated with a certain disdain the disseminated ore minerals which are usually found as essential or accessory components of rocks. This is apparent in their vague designation of these as "opaque constituents." Different ores, as well as particles of carbon and graphite, were brought under this heading without further investigation. The fact was not heeded that these inclusions, in spite of their minute quantity, often plainly indicated the genesis of the rock in question. A microscopic investigation of the composition and structure of actual ore deposits was seldom attempted. Especially were the nonmetallic deposits avoided by the petrographer.

Happily, during the last decade these conditions have completely changed. Everywhere the importance of the microscopic method for the investigation of ore deposits of all kinds has been recognized, especially in the treatment of practical geological questions. Among the first and foremost in this work has been the Freiberg school of geologists, whose efforts have been rewarded with many important results.

It is not intended to relate here in chronological sequence the achievements of the microscopist in this field, but rather to give a review of the results that have been obtained, following in this the order of the systematic classification of ore deposits. The metallic deposits will first be taken up in accordance with the genetic classification in Beck's "Lehre von den Erzlagerstatten."

*This translation of the address delivered by Professor Beck on the occasion of his inauguration as rector of the Royal School of Mines at Freiberg, Saxony, October 3, 1911, was made with his permission by Joseph T. Singewald, Jr., of the geological department of Johns Hopkins University, for publication in Hopkins University. The German title is "Über die Bedeutung des Mikroskopes für die Lagerstattenlehre." It is reproduced from the Engineering and Mining

INFLUENCE OF MICROSCOPE ON CONCEPTION OF MAGMATIC SEGREGATION.

In the very first genetic group, the magmatic segregations, we see that the microscopic apearance of a specimen often alone determines the entire conception of it. It is relatively easy to examine an ore which contains only one ore mineral in addition to the silicates and other minerals which are transparent in thin section. To distinguish several opaque minerals from one another is more difficult. For this purpose reflected light is being used with great success by means of a simple vertical illuminator, or even by direct cases, highly polished surfaces are prepared and electrically illuminated in the Le Chatelier metallographic apparatus. The different ores can then be still further distinguished through careful etching; and recently artificial tarnishing has also been produced and used in the diagnosis. In this way it is possible to determine the order of deposition of the different minerals, and hence gain a valuable insight into their mode of origin.

The study of the platinum of the Urals might be cited. By this means, it was shown that the grains possess a zonal structure, such as is typical for crystals formed from a molten mass, as the augites in basalts or the feldspars in many porphyries. On the other hand, it was brought out that before the separation of the platinum, the separation of the chromite was already complete. Further, it could be shown in some cases where the platinum contained considerable osmium and iridium that crystals of osmiridium or newjanskite were scattered through the platinum trains, their separation taking place therefore between that of the chromite and that of the platinum. The last member of the sequence was always a silicate, olivine. All these observations established the segregation of the rare metal from the molten magma, also in those cases where the platinum occurred together with magnetite intergrown in a pyroxene rock. In the same way the origin of gold has been determined, such as the primary gold in the silicates of certain gabbro-diorites of Madagascar. If, on the other hand, the microscope discloses that, in any igneous rock whatever, native gold is found only where secondary quartz and pyrite occur, then the subsequent introduction of auriferous solutions must be assumed; this is the case in many of the supposedly primary gold-bearing diabases and epidiorites of Australia.

The theory of the magmatic origin of many oxidic chromium and iron ores was greatly fortified by means of the microscope. We know now with certainty that all workable chrome-iron ores were derived from magnesia-rich magmas. The origin of the gigantic ore deposits of Lapland was also worked out primarily through the use of the microscope, though aided by geological field investigations and boring operations conducted by the mining interests.

APPLICATION TO PROBLEM OF SUDBURY ORES.

The problem of the sulphides in the gabbros norites and diabases was more difficult. He who is familiar with the literature on the important deposit of Sudbury as well as that on the small occurrences at Sohland, on the Spree and Schluckenau, knows how difficult it was for geology to arrive at a generally accepted genetic conception of these ores. The microscope has shown that the old view of the magmatic nature of these ores applies to the extent that a part of the existing nickeliferous pyrrhotite and chalcopyrite actually must have segregated direct from the molten magma; and in the case of the great Canadian deposits this was by far the greater part. On the other hand, thin sections show that probably a thermal solution and redeposition of finely divided ore particles took place, giving rise to the formation of compact secondary masses of ore. A metamorphism of the rock preceded this redeposition, so that the secondary green hornblende, which is attached to the pyroxenes in delicate fringes, is in turn surrounded by pyrrhotite. The nickel content of the pyrrhotite is now also explained. The microscopy of highly polished surfaces established as true what had already been indicated as probable, through small-scale magmatic separation, namely, that there is an intimate mechanical intergrowth of common pyrrhotite and a nickel sulphide, pentlandite. The intergrowth is unfortunately so intimate that a commercial concentration is out of the question.

The modern conception of the next group, the contact metamorphic ore deposits, has been made possible largely through the microscope. Often the investigation of a single small sample of such ore suffices to make clear at once its genetic position, since structure and paragenesis are extremely characteristic here. Whoever knows how in accordance with the experience of the last decade the economic value of such contact metamorphic deposits has turned out in comparison with that of the magmatic or other types, will also know how to make commercial use of such a preliminary diagnosis when the occasion arises.

APPLICATION TO FIELD OF THE VEINS.

Within the field of the veins, one group of phenomena in particular has been elucidated, that concerning the replacement processes, or metasomatism. Of course, in certain vein-types these processes were understood in the pre-microscopic period as for example in the tin veins. Charpentier in his day pictured the steep-dipping tin veins of Geyer, which, together with the flat veins, are splendidly exposed, and he described very clearly how in the transition zones the feldspars of the granites were altered to gray quartz, besides cassiterite, arsenopyrite and other ores. The microscope, however, pointed out such phenomena in other vein groups with unexpected frequency. Only with its aid could we, for instance, understand the nature of sericitization, which is so widespread; and only thus were we able to recognize the same transformation along the courses of active thermal springs. It was found that replacement occurs not only in the country rock in place or included in the vein mass; but also in the vein material itself. The microscope decides whether the quartz is a primary deposit or whether silicic acid has subsequently replaced carbonate gangue minerals and barite, as at Schneeberg, or siderite, as in the Sieg district.

REPLACEMENT PROCESSES SHOWN AS OCCURRING IN EPIGENETIC DEPOSITS.

On a far larger scale the microscope has shown replacement processes to have occurred in stock-shaped and bedded, epigenetic deposits. Here, in particular, have thin sections proved, through the presence of fossils replaced by ore whether a cavity was formed and then filled with ore, or whether the original rock was replaced molecule by molecule with the metallic compounds.

There were problems of the greatest scientific and economic interest in the field of the epigenetic bedded deposits, in the solution of which no progress could have been made without the new method. Among others, the problem of the Witwaters and suggests itself here, calling for an abundance of nice investigations, part of which belong to the best known microscopic-petrographic achievements. The microscope soon showed that the early conception of this most famous gold deposit of the world as a complex of fossil gold placers, was erroneous. In its place, it gradually unfolded a picture of chemical-geological processes far more complicated than at first suspected.

These few suggestions indicate that the purely scientific progress attained by the

use of the microscope is to be highly valued. It is not difficult to demonstrate further, however, that the scientific prospector and economic geologist can turn to direct practical account his examinations of thin sections, if they are correlated with field investigations. Above all, the microscopic method tells in many cases to what genetic group the prospected ore deposit belongs. The different genetic types are not of equal economic value. The microscope determines, for instance, in many cases whether one is dealing only with a local enrichment or with the outcrop of a large deposit; in other words, whether only short-lived operations are to be expected or whether the investment of considerable capital is justified. Here, in particular, might be pointed out the cementation phenomena immediately under the gossan, typically known in the case of copper and gold deposits. They are often difficult to recognize macroscopically, but very easily recognized microscopically. Their presence determines a rich zone under the gossan, which formerly was, and even now is, often considered in new discoveries to represent the normal primary development of the orebody. Enterprises basing their returns on the metallic content of this zone may experience a severe setback or complete failure when operations have penetrated through the cementation zone. An examination by reflected light of polished surafces of such secondarily enriched ores reveals their extremely characteristic structure and warns one against committing mistakes.

AID TO SOLUTION OF ORE-DRESSING PROBLEMS.

Much important information can also be obtained by the millman from thin sections. An example is the still unsolved milling problem of the sphalerite ores of the St. Christoph mine, at Breitenbrunn, Saxony. The difficulites of that problem can be understood only after one has seen in thin section the unusually delicate lamellae of sphalerite locked between the cleavage plates of the hornblende, which is besides intimately intergrown with magnetite. At the present time the large testing laboratories generally use only a hand lens or a binocular microscope to test middlings and concentrates. A study of thin sections would, in many cases, greatly shorten the experimental work.

RELATIONS OF OLD DEPOSITS AND ATTEMPTED SALTING DISCOVERED WITH MICROSCOPE.

In the tracing out of old ore deposits, forgotten in the course of time, our instrument can also perform good service. For example, it was successfully applied to determine what sort of ores (particularly the type of the deposit) were worked in an ancient stamp mill in regard to which no records were procurable. The fragments of lean ore particles found in the grass-covered slime-dump revealed such characteristic structures that the investigator was at once oriented as to the nature of the deposits worked; whereas the assayer could have proved only the occurrence of certain metals. In another case the identity of certain rich specimens in an old collection with the meager remnants of an old dump could be established microscopically, and thereby the authenticity of certain records.

Dishonest manipulations also can be detected through the microscope, and in that way business losses prevented. Once the characteristic forms of gold filings with which a swindler had salted a prospect betrayed his scheme. Another time, minute hammer-marks were discovered on artificially flattened, finely granulated brass with which a conscienceless owner of a claim had "improved" a placer showing, the salting of which with real gold alone would have been too expensive.

GENETIC RELATIONS OF BLUE GROUND MICROSCOPICALLY DETERMINED.

Our knowledge of the nonmetallic deposits has also been advanced in many ways through use of the microscope. The theory of the origin of the South African diamonds, for example, has been strongly confirmed by thorough structure-studies of the "blue ground." The genetic relations between that remarkable country rock of the South African precious stones and other known types of eruptive rocks were disclosed only by this means. To be sure, the mere determination of the accompanying minerals often decides in a doubtful occurrence whether one is dealing with "blue ground" or not. Before one undertakes costly explorations and washing tests on a large scale, however, a microscopic examination is essential. Various rocks have been considered "blue ground," which the microscope recognized as not genuine.

COALS AND SALTS SUSCEPTIBLE TO MICROSCOPIC EXAMINATION.

In spite of their apparent opaqueness, the coals are also susceptible to microscopic examination. We already have means of lighting up, to a certain extent, the field of sections and slices. The theory of the origin of coal seams has taken advantage of such investigations, which, of course, presuppose a thorough botanical training on the part of the investigator. It has in this way been demonstrated that algae are the principal constituents of certain saprolitic coals.

The salt deposits still remain to be mentioned, the microscopic appearance of which has recently been used in support of all kinds of theoretical conclusions. Differences in structure permit one to determine, for example, whether certain potash salt bodies belong to an older or younger generation, and this knowledge can be turned to industrial advantage in assisting to unravel the frequently complicated tectonic relations of these deposits. The thin sections are prepared on a ground-glass plate with emery and corozo-nut oil, washed in ether, and mounted in Canada balsam.

APPLICATION TO STUDY OF STRUCTURAL MATERIALS.

In an entirely different field of practical geology, the application of the micorscope enables one to pass an opinion on rocks which are to be used as building stones, as decorative material or as works of art. It has been shown that especially in the investigation of resistance to weathering, the microscope performs important services, which cannot be performed by the other methods customarily used in testing building material. Especially valuable are the comparative microscopic studies of rock used in building which has resisted weathering for a long time and that which is in process of disintegration. The cause of rapid weathering can be recognized as a natural structural relation. Two granites, for instance, of almost identical mineralogical and chemical composition can behave quite differently. The one remains sound for years; the other disintegrates rapidly because delicate microscopic pressure zones run through it. Two marbles of equal beauty show entirely different powers of resistance as material for a work of art exposed to the weather, according to whether the calcite individuals in thin section interlock with sinuous outlines or merely adjoin each other as paving stones.

Recently the microscope has also been applied to the scientific investigation of mortar, stucco, dead-burnt plaster of paris, floor plaster and other important artificial products. Finally, the broad microscopic field of metallography might be mentioned into which, however, we shall not go.

Various circumstances have fortunately greatly facilitated this extensive application of the microscope. The convenient types of this instrument which were placed upon the market at relatively low prices by the German optical industry were of particular advantage in this regard. In addition there appeared a number of good textbooks for the study of microscopic petrography.

From this review the conclusion is inevitable that microscopic petrography must have a place in the curriculum of technical schools and especially of mining schools.

CYANIDE PRACTICE IN INDIA

By HUGH M. LESLIE*

Up to the present cyaniding in India has been practically confined to the Kolar Gold Field, and the management of the various companies owning property on that field, is in the hands of Messrs. John Taylor & Sons, of London. They, as a result of successful tests on a parcel of tailing submitted by them to the Cassel Co., of Glasgow, ordered a plant for the Mysore mine, and Mr. C. J. Ellis and the author were sent to India in 1894; the author to erect the plant, and Mr. Ellis to demonstrate the suitability of the process to the different mines under the management of Messrs. John Taylor & Sons.

When this object had been accomplished, Mr. Ellis returned to England, and the author's whole time for the next two years was occupied in erecting and starting new plants on the other mines of the Kolar Gold Field. On his return to India from leave he was given (in addition to the superintendence of the erection of all the cyanide plants) charge of the running of the cyanide department at Mysore mine, and in 1904 was appointed consulting metallurgical engineer to the mines in India under John Taylor & Sons, in addition to his position as chief cyanide chemist at Mysore mine.

His endeavor in writing this paper, is to outline the work accomplished during a term of over seventeen years residence in the east, and to give as briefly as possible, a description of the treatment by cyanide in India, from the time the process was introduced in 1894 until the present day, and to show the gradual development from the beginning in those days, to the recent cyanide practice, which he thinks will compare favorably with cyanide practice anywhere.

The material treated on the Kolar gold field prior to the introduction of the cyanide process was confined entirely to sand which was rich enough to pay for treatment by pan amalgamation. This was uniformly a very coarse sand, which contained the greater portion of any pyrite existing in the ore, and which in any case would have required regrinding to ensure a high extraction by any modern method of tailing treatment. That the extraction by this method was not entirely satisfactory was shown, as on the introduction of the cyanide process, it was demonstrated that the pan residues could be profitably retreated.

The following brief description of the methods in those early days of handling and dealing with the mill pulp, tailing, etc., is necessary so that the conditions then existing, and under which the cyanide process was introduced may be more readily understood. The pulp from the stamp mills for treatment in pan mills was conveyed by launders, and collected in a first series of rectangular masonry vats called "mill pits," from which it was discharged by hand, and taken, at intervals as required, to the pan mills for treatment. The effluent from these vats, containing the fine sand and slime, was conveyed in drains to a further series of similar pits called "slime pits," or "catch pits," in which the slime settled. The fine pulp from the pan mills, after regrinding and amalgamation, was also conveyed to a series of "slime" or "catch pits" although it was sometimes allowed to mix with the effluent from the "mill pits." It was common practice at this time to allow the coarser sand in the reground pan mill pulp to settle out in the drains, before reaching the "slime" or "catch pits" proper, as this product was of a higher assay value.

The method employed for collecting all these various products was by hand labor, with one exception at the Ooregum mine, where a steam grab or dredger was used for this purpose, but it was a very debatable point as to whether this was a more economical method, with the cheap and abundant supply of native labor available. At the time of the installation of these sand and slime pits, the possibility of the future retreatment of the tailing, by other and more economical methods was not allowed for, the question being simply one of the recovery of the water. The result was, that large accumulations of tailing, varying considerably in character, came into existence.

For several years the cyanide process was called upon to treat these various classes of tailing, all of which had undergone a more or less lengthened exposure to the weather. The pan tailing was found on experiment to be the most amenable to cyanide, and it was consequently on a deposit of this material collected from drains as above mentioned, that the cyanide process was first used and the success of the process demonstrated. The general method of delivering the sand into a cyanide plant was to charge direct to the percolating vats, after having the lumpy, dry, slimy portion thoroughly powdered. This was all done by hand labor, screens, riddles and such like being used. After powdering, the sand was conveyed by trucks and dumped into the vat to be filled, one or more coolies being employed in leveling during charging. The discharging was also done by hand labor, the sand, after treatment, being thrown over the sides of the vats, and conveyed to the discharge dump by means of trucks pushed by coolies. In the case of one plant at Champion Reef, side discharge doors were tried, but they gave so much trouble by leakage, that they were soon given up and the foregoing method for discharge adopted.

As before mentioned, the old tailing, which had not been stored with a view to future treatment, was the first product to be treated by the cyanide process, and the plants were therefore erected on the sites which happened to be the most suitable under the circumstances. Centralized tailing treatment was thus greatly handicapped at this stage of the development of the process in India. These old piles of tailing were composed of very finely ground sand, mixed with slime which had settled out in the slime pits; and when these piles came to be treated, they consisted of hard, weathered material, which had to be broken up, before it was in a fit state for lixiviation in the cyanide works. One peculiarity, common to all the mines on the Kolar gold field, was the amount of mercury which was extracted during treatment by cyanide. It was a distinct trouble to the chemist in charge and entailed a great deal of extra work at clean-up, the method of which will be described later. Owing to the large proportion of slime in the material, and the consequent difficulties of percolating, it was found that, to get a good extraction, the vats could not be charged to the top, unless the vats themselves were made shallower than those in common use for ordinary sand treatment. If this practice was not adopted lixiviation was greatly retarded, channels formed, and a poor extraction was the result. In every case vacuum had to be applied to assist in the drawing off of the liquid from the ore undergoing treatment, a practice which is still in general use.

*In Journal of The Chemical, Metallurgical and Mining Society of South Africa, March, 1913.

METHOD OF TREATING PAN SLIME.

The author's method in treating this "pan slime," as it was called, was as follows: The first solution applied, about one-third of the weight of slime to be treated, tested from 0.12 per cent to 0.15 per cent KCN. This was percolated upwards till the surface of the sand was covered, and the remainder then run on top. This procedure, proved to be the best method, as it was found that by running the first or strong solution on top, a thin layer of impermeable slime formed on the top of the charge which very considerably retarded percolation. The first solution was allowed to soak for about six hours, and was then drained off. Two or three washes testing from 0.10 to 0.04 per cent KCN, and a final water wash were then run on in rotation and drained off. The practice was to give as many washes as possible, and suction had always to be applied towards the finish for a longer or a shorter period, as the filtering properties of the slime demanded. The total quantity of solution used, was from 70 tons to 80 tons per 100 tons of slime treated.

The amount of mercury which was extracted from this "pan slime" was considerable, as much as from ¾ oz. to 1 oz. per ton being common. This mercury was deposited in the extractor boxes, and materially, and adversely, influenced the quality of the bullion which was obtained. Its effect was to make the whole of the zinc exceedingly brittle so that the contents of the first three or four compartments were amalgamated and formed a zinc sludge, the greater part of which was zinc. This had all to be removed at clean-up, together with a proportionately large amount of short zinc from the other compartments, in order to prevent a continual congestion of the boxes.

The extraction of gold by cyanide was always satisfactory, notwithstanding the presence of the mercury in the material. The average original assay was from 2 dwt. to 3½ dwt. per ton, and the residue assayed from 8 gr. to 21 gr. of gold per ton, as the weather and other conditions of treatment varied. A precaution which was found to be necessary in dealing with the leachings from this class of material, was that the gold bearing solution, before passing into the extractor boxes, had to be freed of any slime which might have been drawn through the filter cloths of the percolators. The most efficient type of settling vat for this purpose, was found to be one constructed after the pattern of an extractor box but of a much greater depth, each compartment being packed with cocoanut fibre to which the fine particles adhered. These were cleaned out at intervals.

In the treatment of the old accumulations as already described, little or no free acidity was found, but on one or two of the mines a large amount of latent acidity was encountered. At Ooregum mine this was found to be cause by the presence of sulphate and chloride of magnesium. These salts were traced back to the water used in the mills and cyanide works, and their action on cyanide is commonly represented by the following equation:

$$MgSO_4+2KCN+2H_2O=$$
$$MgH_2O_2+K_2SO_4+2HCN.$$

The admixture of caustic soda with the cyanide solutions neutralized the destructive action of the magnesium salts, and it was found merely necessary to add the caustic soda to the cyanide solution instead of being applied as a preliminary alkaline wash. Cheaper alkalies were experimented with, but caustic soda was proved to be the most satisfactory, and its use has now become more general on the Kolar gold field, where the use of alkalies is found to be necessary.

The ore encountered is free milling. The percentage of pyritic concentrate varies on the different mines, but taken as a whole it does not average more than 1½ per cent, and for this reason the sand can be weathered without detriment. The weathering, whilst oxidizing the pyrite, and freeing the gold contents, is further advantageous in freeing the sand of surplus moisture (reducing it from 12 per cent to 16 per cent down to about 3 per cent). This converts it to a more friable state, any slime present can be easily powdered and having no water to displace can be thus easily saturated with solution, and the lixiviation and subsequent washings more thoroughly and quickly carried out. To illustrate this the following large scale experiments are interesting: Some hundreds of tons of sand, taken directly from one of the series of settling pits at Mysore, were dumped separately and allowed to weather thoroughly for about four months, being turned over at intervals, so that the weathering would be as thorough as possible.

(a) A vat was charged with the above sand and put through a 48 hours' treatment in the usual way.

Result: Original assay, 3 dwt. 17 gr., gold per ton; Residue assay, 1 dwt. 2 gr. gold per ton.

(b) Sufficient of the same sand was then charged into a similar vat, after being first saturated with water to about 15 per cent. It was put through a 36 hours' treatment.

Result: Original assay 3 dwt. 17 gr. per ton; Residue assay, 2 dwt. 3 gr. per ton.

(c) To ascertain whether a better extraction could not be obtained from the dry sand, with a longer treatment, another vat was charged with similar weathered sand and treated for 72 hours.

Result: Original assay, 4 dwt. 21 gr. per ton; Residue assay, 2 dwt. 3 gr. per per ton.

(d) A vat was charged with sand taken directly from the sand settling pits as they were being emptied, and given the same treatment as (b).

Result: Original assay, 4 dwt. 0 gr. per ton; Residue assay, 3 dwt. 12 gr. per ton.

The residues from these trials were graded and assayed, and the conclusion arrived at and subsequently acted upon was, that the worst extraction was chiefly due to the slimy lumps. These lumps being impermeable to the solution did not yield their gold content, as they held up their original moisture which could not be replaced by cyanide solution. The treatment of weathered mill sand has been tried in many ways and under all conditions, and it has been clearly proved that if a dry product containing no lumps is charged into the vats, the bulk of the gold contetns can be extracted; but if too much moisture is present the extraction is not satisfactory, as a stage is reached when washes are not effective in liberating the dissolved gold, caking, and channelling of the charge and choking of filter cloths having taken place. An important consideration which affects this question is that for nine months of the year, there is practically no rain-fall, and it is noticed that during the wet weather the extraction in the cyanide works is never so good as after a spell of dry weather.

SOLVING IMPORTANT PROBLEM.

The success of the cyanide process having been once established, the question of the collection and preparation of tailing for future treatment became an important one, and was given more consideration than it had previously received. It was proved that the mill sand before treatment had to be carefully prepared to give good results, and to attain this as rapidly as possible, the wet pulp from the mill settling pits was dumped in two or three separate heaps which were worked off in rotation. The piles to be treated had to be powdered in exactly the same manner as the pan slime. In working through a pile, it was found best to work over its face, and

after exposing a fresh surface, to leave that for a time to the action of the sun, before transporting to the cyanide works for treatment. The grade of these old piles was found to vary considerably, and after a series of experiments it was suggested by the author that a standard screen, from 90 mesh to 110 mesh be adopted for the stamp mills on the field. This was acted on with satisfactory results. As the larger cyanide plants afterwards erected more rapidly overtook the mill production of crushed material, it sometimes happened that the more slimy portion of the tailing was not sufficiently dried, with the consequent decrease in the extraction, owing to the impermeability of the wet slime, as before mentioned.

It was at this time about twelve years ago, that the author advised the use of collecting vats, fitted with distributors, to replace the existing mill settling pits. Experiments had been tried on a large scale to determine the method of these experiments demonstrated: (1) That it was necessary for successful treatment to have an evenly mixed mass of sand and slime, and (2) it was also an advantage to have this weathered as long as possible before treatment. If these two conditions could be obtained, loss could be prevented, and the extraction greatly improved. The introduction of collecting vats and the increasing size of the discharge dumps, necessitated, in a number of instances, the use of power plant to convey the sand to where it would be dumped. The problem to be faced in discharging was to obviate the difficulty of increased height of the dump, which would render later, some hoisting arrangement necessary, and to overcome this, various methods were introduced. In one instance an old pan mill building had to be utilized as part of a cyanide plant installed for the purpose of working off the large accumulation of pan slime with which it was surrounded. This being situated on the lowest lying ground of the property, and adjoining the boundary line, it was for economical reasons necessary to treat the material on the spot. The charging arrangements were ideally simple, but to get over the discharge difficulty a high wooden incline was erected. The height of this from top of the incline to the level of the discharge from the vats was 60 feet. It was provided with four tracks, and four platform trucks worked in pairs, each pair being independent of the other and having its own winding engine. This arrangement proved an expeditious and satisfactory method of discharge. The incline was constructed entirely from useful and common sized battens. In standard lengths bolted together, and these were readily used for other purposes when the accumulated slime had been worked off. In erecting new plants, a common method was to utilize the site in such a manner that the necessary height could be obtained at the charging end, by hauling the sand to be treated up an incline by means of trucks attached to a steel rope, worked by a winding engine.

At the Champion Reef collecting vats, the conveyance of the material from these vats to the cyanide plant, was conducted by means of an aerial ropeway. The system adopted was the "Otto," two carrying ropes, and an endless hauling rope, with automatic engaging and disengaging gears, being employed. These vats were emptied through bottom discharge doors, the sand being fed directly into the buckets of the aerial ropeway, which were suspended below the vats on a system of hanging rails. The buckets, when filled, were pushed by hand to the loading station, and there engaged by the automatic loading gear, and carried by means of the hauling and carrying ropes to the unloading station, where they were dumped into the trucks used for conveying the sand to the dumps from which the cyanide plant was charged. This ropeway has been working since 1902. It conveys the sand to be treated, a distance of about 200 yards to a height of 90 feet, or about 25 feet above the level of the percolation vats.

THE MYSORE PLANT.

The largest sand handling plant on the Kolar gold field, has been erected at the Mysore mine. The collecting vats of this plant are discharged by means of bottom discharge doors on to belt conveyors, which elevate the sand a height of about 40 feet above the level of the charging tram roads of the cyanide works, or to a total height of about 72 feet. These belts were at first arranged to work off one engine, the driving shaft being provided with a separate clutch for each belt (the belts running parallel, and each being in one piece). These belts had each a length of about 500 feet from the center of the terminal tightening pulley, to the center of the terminal discharge pulley, but it was found from experience gained, that the working could be facilitated, and the wear and tear minimized, by substituting two shorter belts in place of the one longer belt. The sand is charged on to a horizontal belt running the whole length of the collecting vats, and this in turn is discharged on to an incline belt. The sand on reaching the top of the incline, is discharged into a hopper from which trucks are filled and pushed by hand to the edge of the dump in course of preparation. The dumping station, and incline carrying the belts, were made of steel trellis work, the lower half of which was filled up with waste material that did not require to be removed. A great difficulty was at first experienced in getting the feed of the belts from the collecting vats properly adjusted. This was, however, overcome by means of a straight sided hopper, hung below the discharge door. This, in turn, fed on to a wide shallow hopper, about 4 feet long by 3 feet wide, provided with a discharge opening, or chute, the full length of the hopper and running in the same direction as the belt. This chute was about 3 inches to 4 inches in width and the sides, finished off with rubber insertion, were just long enough to clear the moving belt. To prevent the sand from falling directly on to the belt and choking, and also as a safeguard should any of the workers' tools fall through the discharge door, a protecting length of angle iron (4 inches or 5 inches) was fixed above the belt and directly over the feed chute, the angle pointing upwards. By this means, and with the assistance of a man with a small hand shovel, the feed could be kept even, and overloading the belt rendered impossible.

The sand from the collecting vats is stacked so that it may have as much drying and weathering as possible before treatment. It consists of an even product, free from slimy lumps, but having a fair proportion of slime evenly distributed through its mass. The necessary drying is obtained by building up piles in rotation, and working off the oldest in the same manner as that used before the installation of collecting vats, except that with it no lumps have to be broken up, as the slime present is intimately mixed with the coarser sand. In this case, however, prolonged sun-drying is unnecessary, as the sand is freed from excess moisture while still in the collecting vats. The Mysore mine, on which the above mentioned plant was installed, has three stamp mills, with 120, 60 and 30 heads of stamps respectively, and the tailing therefrom was treated in three widely separated cyanide plants, two of which had been erected originally to treat dumps of the old pan tailing, and the other for the output from the 120 head mill when it was erected. This division of the works could not be called satisfactory, and as it became essential to introduce some more suitable method of collecting the sand, to replace the old settling pits originally laid down, the author designed a system for centralizing the sand settling arrangements, so that the whole output from the three

mills could be treated in one cyanide plant as follows. The pulp from the three mills is carried in launders of 12 vats, each 30 feet by 6 feet deep. These are discharged on to the two conveyor belts already mentioned (one belt for each line of six vats), which in turn convey the sand to the dumps for treatment in the cyanide plant. The collecting vats are provided with sand filter bottoms (filtering cloth of various materials was tried but discarded, as the cloth rotted too quickly). When a vat is full, a drain cock is opened, and as much water as possible drained off by gravity. Vacuum is then applied for a few hours and the sand is then ready for discharge. About four hours is required to empty one of the above vats, the usual time taken for draining and empting a vat occupying about ten hours.

The cyanide plant in which this material is treated was originally laid down for the 120 stamp mill only, and it at first consisted of nine percolators, each 30 ft. x 6 ft. deep. These vats were charged from the west side, but when the central treatment system, by which all the tailing was to be treated in this plant, was installed, it became necessary to increase their number, and to charge them from the north end. The first increase was effected by the addition of three more vats of the same capacity as the others. Improvements having however been effected in the stamp battery crushing, a corresponding increase in the cyanide plant was required. To meet this, four more vats of 36 ft. dia. were laid down, and latterly the nine original vats were replaced by vats of a greater capacity.

Much the same treatment is given to the sand from the collecting vats, as was the practice in treating the mill tailing dumps before their introduction. The first, or strong solution, testing from 0.13 per cent to 0.16 per cent, is either run on top or percolated upwards and allowed to soak for six hours or so. It is then drained off, and as soon as the solution disappears below the surface of the sand, a so-called solution wash, testing from 0.1 per cent to 0.13 per cent, is applied. Then follow about five weak washes from 0.08 per cent to 0.05 per cent strength and a final water wash. Vacuum is applied at the end of the treatment, to ensure the discharged sand being as dry as possible. It was customary in the earlier days to use a higher percentage strength of cyanide for the first solution, but by experience this was found to be unnecessary, and simply increased the consumption of cyanide without a better result being obtained.

The extractor boxes used, and still in use to the present day, are nearly all of the central launder type. This type which the author designed for the Cassel company has proved in his experience, to be quite as efficient as any of the side launder types, and easier for the operator to clean-up. It is also more compact, and easier to keep under lock and key, where this is necessary. The ordinary clean-up arrangements in connection with the reduction of the gold slime obtained from the old pan mill tailing varied according to the ideas of the chemist in charge. The general plan involved discharging the finer contents of each compartment, through the launders, to a vacuum filter box, sieving to remove coarse zinc which was returned to the extractors, treating with acid, smelting, and finally melting the buttons into bars. The roasting of the gold slime was a very important point, affecting the subsequent purity of the bullion, and the author's experience was that the trays, after being charged, should be left untouched until their contents are nearly all oxidized; this usually took from half to three-quarters of an hour. By this means dusting, the great drawback to this operation, was practically avoided, but if the trays were disturbed at this stage, dusting always resulted. The heat was always carefully regulated to prevent volatilization.

The retorts necessary for the recovery of the mercury obtained from the pan mill slime were cylindrical, each being provided with one long movable tray and fitted with covers that could be locked. The usual form of Liebig's condensers were used for condensing the mercury. The roasting furnaces were in batteries of from three to ten, and consisted of cast iron trays hooded over with brick. They were fired from below, and the fumes and combuston gases were carried each by a separate flue to a large main flue, which could be cleaned out when necessary.

The smelting furnaces were arranged for forced draught, and each consisted of a rectangular fire-box, large enough to hold two No. 80 Salamander crucibles. Into the bottom of this fire-box the air for the combuston of the coke used was forced by means of a jet of steam or compressed air. A charge usually took about forty minutes to run down. To recover the gold contained in the slag from smelting operations, ash, clinkers, crucible scrapings, sweepings from floors, etc., the author many years ago introduced as part of the cyanide clean-up process, an amalgamation pan through which every such by-product likely to contain gold is passed. Everything which has to be treated in the pan, is first ground in a ball mill to one-eighth mesh, and then reground with mercury in the pan. Each charge receives about three hours grinding, after which it is discharged over riffles, and collected in a settling vat. What is caught in the riffles is put back into the pan for further grinding, and the contents of the settling vat are stored. The amalgamation pan is cleaned up as required and the recovered amalgam retorted, the resulting sponge being added to the next month's bullion at melting. The tailing from this process is rich, and when sufficient has been accumulated it is treated by cyanide, which usually yields an extraction of about 90 per cent of the gold contents. The gold slime from the mill tailing is not as a rule retorted, as the mercury would scarcely pay for retorting. In roasting this class of product, however, it was always left untouched till all mercury had been volatilized, and when this condition was properly observed, the loss due to dusting was reduced to a minimum. The above brief description of the clean up is a summary of the general practice on the Kolar gold field till some years ago, but it has since been considerably modified, by several improvements in zinc box practice introduced by the author, which have been in successful operation for a number of years.

PRECIPITATION IN THE EXTRACTOR BOXES.

With regard to the precipitation of the gold on the zinc, the original practices was, to use one-half of the extractor box capacity for strong solutions, and the other half for weak solutions. It was noticeable, however, in this that the weak boxes invariably contained as much slime at clean-up as the strong boxes, but that it was not so rich in gold. To get a more even product, about eleven years ago the alternate use of the boxes was tried, those getting the strong solution one day, getting the weak the next, and vice-versa. This proved a decided success, the resulting slime at clean-up being more uniform, and the precipitation equally as effective as before.

It was further noticed, that when at any time the tonnage of a plant was reduced, thus giving less gold to precipitate, the bulk of the slime from the extractor boxes remained much the same, without any improvement in the precipitation being noticeable. This pointed to the possibility that the excess of zinc was more a disadvantage than otherwise. In other words, this excess of zinc acted as what might be called a chemical filter, and precipitated other compounds in the extractor boxes. This was prob-

ably due to the subsidiary re-actions set up between the zinc, cyanide, and alkali plus atmospheric oxygen, and the result, taken from a reduction point of view, was undesirable.

Working on this basis, the author started to reduce the amount of zinc in the boxes, and after trials at the Mysore mine lasting over two years, it was found that from the solution used in treating 10,000 tons of tailing per month, as good precipitation could be obtained by using thirty-seven cubic feet of space occupied by zinc shavings, as was obtained from the ninety-seven cubic feet previously considered necessary. This resulted in a great saving of time and materials, and instead of four full extractors to clean-up, two partly full were found to be sufficient, at the same time the quality of the slime was greatly improved, and the quantity to be handled much less than it had ever been before. The fineness of the bullion also increased in much the same proportion, varying from 860 to 910 fine gold, with from 45 to 65 of silver per 1,000 parts.

The following table showing results from one set of vats under treatment, is characteristic of what is to be expected with the reduced zinc precipitating surface.

There are a few important points that must be observed in connection with this reduction of zinc precipitation surface. The extractors used must be perfectly solution tight so that no one compartment can leak into another, otherwise the precipitation will be imperfect. The boxes should also be packed with clean

Vats Nos. 7 and 8		Before Extractors			After Extractor	
Sample	Interval	Strength of solution	Assay per Ton Solution		Assay per Ton Solution	
		per cent.	dwt.	gr	dwt	gr
1st	5 hours	0.105	0	13	0	3
2nd	"	0.040	1	13	0	3
3rd	"	0.040	4	11	0	[illegible]
4th	"	0.045	4	17	0	[illegible]
5th	"	0.060	4	7	0	[illegible]
6th	"	0.070	3	14	0	3
7th	"	0.070	2	15	0	3
8th	"	0.050	2	2	0	3
9th	"	0.050	0	23	0	3

shaving (the thinner the better, as coarse zinc gives very poor results), fresh from the lathe, and if this cannot be obtained, the dust and short zinc should be got rid of as much as possible before packing. The packing should be done firmly and with as little tearing as possible. The rate of flow of solution through the boxes can be as fast as possible without overflowing the compartment, when these boxes have a fall of one to twelve. Two extractors should be all that is necessary for any gold ore treatment plant, provided they are designed properly. Each should have four or five compartments for containing zinc shaving, with two or so left vacant for emergency at either end. The precipitating space should be about 0.4 cubic feet per 100 tons of the monthly tonnage treated, and the compartments should be provided with plenty of space below the trays. The boxes should be used day about, or changed at shorter periods for strong and weak solutions. The zinc should be prevented from floating up, and choking must be avoided; a convenient arrangement being the use of ¼-inch mesh trays laid on top of each compartment, and so fixed that the contents are prevented from rising above the same. They should receive regular and daily attention, and be cleaned up once a month, or oftener if necessary. The presence of much silver in the solution makes the precipitate much bulkier, and if required the spare compartments can be brought into use. The quantity of zinc used per ton of sand treated, averages from 0.06 pounds to 0.08 pounds.

Instead of the simple filter box at the end of the extractor for filtering the gold slime at clean-up, a steam jacketed filter box is used. This does away with the double handling necessary for the drying of the slime before smelting when the steam jacketed filter box is not used, The procedure at clean-up is as follows: The boxes are cleaner in the ordinary way, the gold slime being washed into these filters by means of the central launder in the extractor box. After the excess moisture has been drawn off by means of vacuum, steam is turned into the steam jacket and the slime is thus quickly dried to the point which by practice is found best. It is customary to leave enough moisture in the slime to prevent dusting during handling, and when it is being mixed with the fluxes preparatory to smelting. The slime is then conveyed to the smelting room, and mixed with manganese dioxide, borax glass (ground) and sand. This mixture is charged into Salamander crucibles and converted to bullion in the usual way.

The following table shows the cost of smelting slime from which bullion weighing 1,673 ounces was obtained, the fineness being 870 fine gold:

	Pence per Ounce Fine Gold.
Borax	.32
Manganese	.11
Coke	.94
Crucibles	.79
Steam	.09
Native Labour	.04
Soda	.00
Supervision	.33
	2.62

The cyanide works on the mines were directly under the charge of a chief cyanide chemist, who had one or more assistants as required. All testing of solutions, assaying, cleaning-up, and supervision was done by them. Each plant had three foremen (with sometimes one extra as well), whose duties consisted in the carrying out of the treatment, as directed by the cyanide chemist. The native labour employed consisted of three firemen, where steam power was used, three engine drivers (or motor drivers as the case might be,) who attended to the engine or motor, lathe, pumps, shafting, etc., and in addition two or three spare coolies were employed whose duties were to keep the works clean. The natives' pay varied from 8d. to 6d. per day of eight hours. The charging and discharging was done by native contract. The cost of both together averaged from 3¾d. to 4½d. per ton of dry sand treated.

The consistent economic improvement in the working of the process on the Mysore mine, may be gauged by comparison of the working costs, as the following figures will show:

The foregoing outlines what has already been accomplished, but further developments in the application of the cyanide process may be looked for. For some years prior to his retirement the

Year	Tonnage		Total Costs			Cost per Ton.	
	Long Tons	Short Tons	As Published			Long Tons.	Short Tons
			£	s	d	Pence	Pence.
1902	[illegible]	128,294	11,476	4	6	24.04	21.46
1903	126,646	141,843	11,313	6	11	21.43	19.14
1904	Not available at time of writing						
1905	166,491	[illegible]	11,947	9	2	17.32	15.47
1906	158,848	177,909	10,854	18	[illegible]	16.40	14.64
1907	167,529	187,632	11,588	11	8	16.60	14.82
1908	184,643	206,800	12,066	2	7	15.68	14.00
1909	190,388	213,234	12,581	4	5	15.85	14.16
1910	[illegible]	213,393	12,321	9	10	15.52	13.85

author recalled that by means of tube milling better and more satisfactory results would be obtained. He also emphasized that the question to be decided with low-grade slime was dependent on the efficiency of the slime plant to be installed, and that this question would become more prominent with the introduction of tube mills when the percentage of slime would be increased, as the benefit to be derived from their introduction would be so largely dependent on the profits obtained from the treatment of the slime.

Although no mention had been made of some of the more modern methods of treating tailing, these have received very careful attention. The question of classification and regrinding of years one on which for a number of years much time has been expended by the metallurgical staff at Kolar, and numerous experiments have been carried out and a large amount of practical work accomplished in this direction. The author as consulting metallurgical engineer had charge of a central laboratory during his last six years in India and conducted a large number of working scale tests on these points and also in connection with the treatment of slime. These included experiments with most of the modern types of filters. Since then tube mills and filter plants have been introduced and he is of opinion that it is only a question of time when their use on a large scale will be adopted on all the mines on the Kolar field.

AN OUTLINE OF MINE ACCOUNTING

By HENRY B. FERNALD.*

The difficulty in writing of mine accounts comes from the fact that each mine has its own peculiarities, problems and methods. The varying conditions of operation and organization will naturally call for corresponding differences in forms of cost sheets, divisions of accounts, timekeeping methods, storehouse accounts, etc. There is, therefore, no fixed standard by which mine accounts should be judged since each mine should have the accounts and records which will present with accuracy, clearness and economy the facts regarding its operation and financial condition.

But in spite of the multitude of varying details to be considered in each case, there is a general scheme of accounts which must apply to every mine in accord with the very nature of the mining business. If its general outline can be kept clearly in mind, the questions regarding details are much more readily settled, and more satisfactory operating and financial statements will result. It also gives a common ground for the operating and accounting departments to meet, without requiring the one to consider bookkeeping details nor the other to pass upon engineering matters.

The outline as here presented will not, therefore, attempt to recommend special bookkeeping methods nor to decide engineering propositions We should know the cost of mining irrespective of whether it is surface or underground. This must include development costs, either as the expenditures are incurred, or proportionately to the tonnage of ore extracted. All the accounts may be kept at the mine or they may be divided between the mine and the home office.

ESSENTIALS OF MINE ACCOUNTING

But whatever is done along these and other lines, the essential facts stand out that, having at hand the mining property:

Expenses are incurred as labor, supplies and sundry charges, for operation, equipment or development.

The result of all expenditures is the tonnage of ore, of a certain metallic content, which is mined and is marketed (either before or after treatment.)

This yields a profit or a loss on the mining operations, which, together with the result of rentals, and any other miscellaneous transactions of the company, will be its net profit or loss. A profit may be distributed to stockholders as a dividend, may be held as current working capital, or may be expended for equipment, development, etc.

The financial condition of the company at any time is shown by the statement of its resources and its liabilities. The resources may be the current working capital of the mine, the deferred charges to be made against its subsequent operations, and the fixed investment in property, equipment, etc. The liabilities may be for current or for bonded indebtedness.

This statement of resources and liabilities does not, however, take note of the most important factor in determining the value of the mine, i. e., the value of the ore remaining in the mine. The current assets, such as cash, accounts receivable, inventories, etc., are usually to be considered as worth their face value. The liabilities should, of course, be paid in full. But the accounts for property, equipment and development can only represent the expenditures which have been made therefor—the question of value being dependent almost entirely upon the more or less uncertain problem of future ore supply.

This is the situation common to every mine, and is the common ground which all mine accounts must cover. The accounts must, therefore, lead to four statements or groups of statements:

I—Costs.

II—Production.

III—Profit and loss (and surplus.)

IV—Assets and liabilities.

The series of outlines which follows is planned to show the general scope of each and their relations each to the others, understanding that the various details of these statements and the forms for their presentation must be a matter for separate determination in each case.

THE MAKE-UP AND DISTRIBUTION OF COSTS.

For conveniences of phrasing, we will consider the current costs as being primarily incurred for:

Labor—As shown by the pay roll and time-keeper's records.

Materials—As shown by the storehouse records.

Sundry expenses—To include the numerous items, which are neither labor nor materials, as shown by the records of the general office.

The records in each case should show how these apply as:

Direct costs of operation.

Direct cost of improvements, construction and other capital accounts.

Distributing accounts (where the labor, materials, etc, do not apply, as such, directly to operation or capital accounts, but require an intermediate grouping, such as power, etc., which is in turn to be distributed to the various operating or capital accounts.)

The total current cost for each division of operating or capital accounts will accordingly be the direct cost, plus the proportion of the distributing accounts which apply thereto. The "current costs" which thus result will not take into account the items of depreciation and of deferred charges.

Whatever may be the basis for charging depreciation, as determined from the engineering standpoint, we must in some way or other make a charge to operation which will, on a proper basis, cover the loss in value of equipment, construction, etc., as operations proceed. Therefore, instead of charging to operation the current costs of construction, equipment, etc., these would be charges to the proper capital accounts; operation being chargeable with the depreciation applying to

[illegible] Mining Journal [illegible] 1913.

the current period, which might be more or less than the current construction or equipment costs.

The matter of deferred charges is probably the most difficult question in mine accounting. Briefly, it is the question of what operating costs are to be stated against future as distinguished from current product. It is manifest that the cost of mining and transportation for ore on hand in the mill bins at the end of the month is not properly a part of the cost of the mill product for that month, but is a charge which should be deferred until it can be stated as a part of the cost of the product resulting from that ore. It is also a fairer measure of cost to apply the cost of stripping proportionately to the tonnage made available than to charge against current production the stripping done during that period. These, and other more difficult features, are primarily engineering questions, the answers to which must come from the facts in the case, rather than from accounting methods.

What the accounts should show clearly and definitely is the amount of expenditures for capital accounts or deferred charges, the amounts charged against operations and the basis on which the charges have been made.

WHAT OPERATING COSTS SHOULD SHOW.

A summary of operating costs may therefore be shown as follows:

Direct charges to operating accounts for labor, materials and sundry expenses;

Add charges for the proportion of distributing accounts which apply to current operation;

Giving the total current operating costs;

Add depreciation;

Add previous deferred charges applying to current production;

Deduct any current costs which are to be deferred charges against future production;

Gives total cost chargeable against current production.

The corresponding summary for capital accounts would be:

Balance of capital accounts at the first of the period;

Add current charges to capital accounts (being the direct charges for labor, materials and sundry expenses, plus the proportionate charges from distributing accounts, if any);

Deduct depreciation chargeable to operating accounts;

Gives balance of capital accounts at the end of the period.

A summary of deferred charges would be along the same lines.

PRODUCTION RECORDS.

The details of production records will be determined almost entirely by the character of the ore and its treatment, and the manner of its sale. They should be such as will clearly follow the movement of the product from the ore mined to the ore, concentrates or metals sold, giving all the important information from stage to stage. Although the ledger accounts only take up the facts which can be expressed in dollars and cents, there is such a close relation between the metallurgical data and the final value of the product as to form a single, continuous set of records to correspond to the progress of the ore.

At first the ore simply stands in the accounts as representing its cost to the stage it has reached. Finally, however, it reaches the point where it is to be taken into the accounts at the value of its metallic content which is in marketable shape. The distinction must be made between the gross value of the metallic content, the amount of metal which will be paid for, and the net amount to be received after deducting the charges for treatment, transportation, etc.

Although the general law is that profit can only be considered as earned when an actual sale is made, it is customary in mine accounts to consider the profits when the product reaches its marketable form, as ore, concentrates or bullion ready for shipment. The advantage of having the clear statement of what the mine is doing more than balance the comparatively slight variations which will result from the use of mine assays and estimated marketing expenses.

SUMMARY OF THE PRODUCTION RECORDS.

The summary of production, on this basis, would be as follows:

Gross value of production;

Less smelter deductions, treatment and freight;

Gives net settlement value of production.

If, as is usually the case, part of this production is on hand, in transit or at smelters and not yet paid for, there would also be a summary to show;

Production for the period;

Product on hand, in transit and at smelters at the first of the period;

Giving total production to be accounted for;

Less production settled for during the period;

Leaves the product on hand, in transit and at smelters at the end of the period (which would agree with the total of the individual lots of unmarketed product).

PROFIT AND LOSS.

While one purpose of the cost and production records has been to show from an operating standpoint the costs per ton, foot, yard, etc., and the recoveries from ores, these same records should lead to the balancing of production against cost, to show the profit It will be recognized that this is practically nothing more than a grouping of the summaries previouly given.

The profit is not the difference between the cash received from production sold and the cash disbursed in payment of bills.

As already pointed out, consideration must be given on the one hand to the production not yet settled for, and on the other hand, not merely to the distinction between cash paid out and expenses incurred, but also to the questions of capital and deferred charges and the cost which is properly chargeable against current production.

In addition to the profit from mining operations, there will usually be certain miscellaneous items such as rentals, store sales, etc. Although these may sometimes be of such importance to require a complete set of accounting records for each, such accounts will merely follow the ordinary commercial methods, showing the resulting profit or loss.

SUMMARY OF PROFIT AND LOSS ACCOUNT.

The summary of profit and loss may accordingly give:

Gross value of production.

Less cost of production.

Less smelter deductions, treatment and freight

Giving mining profit and loss.

Add or deduct miscellaneous profits or losses.

Giving net profit or loss for the period.

Add the balance of profits at the beginning of the period.

Deduct dividends paid.

Gives the balance of profits remaining at the end of the period.

ASSETS AND LIABILITIES.

The general divisions of assets and liabilities have already been referred to. Under the divisions will appear such accounts as the conditions in each case may call for. The exact title to be used for each account is of comparatively little importance, so long as it signifies clearly the nature and scope of the account, and so long as the accounts are so carried that the value of each and its relations to other accounts will be readily apparent.

In addition to the accounts for actual indebtedness which will appear on the liability side of a financial statement, there will also be the accounts for reserves, capital stock and surplus. Re-

serves do not represent actual present indebtedness, but stand on the liability side of the statement to represent a reduction in the net value of the assets to allow for indebtedness which will have to be paid at some future date or for assets which must sooner or later be replaced or written off. Capital stock appears on the liability side to show what the business should return to the stockholders to make good the par value of their stock.

If the total assets exceed the total indebtedness, reserves and capital stock, this excess will be a surplus appearing upon the liability side to balance the account. A deficit will be the necessary figure to balance on the asset side.

A brief statement of the relations which increases and decreases in the various accounts bear to one another, may be of value. For example: An increase in the working capital of the mine can be obtained by increasing the indebtedness, by selling stock, by earning profits or by liquidating other assets. Similarly, borrowed money may be used for paying other liabilities, for increasing current, deferred or fixed assets, or may be paid out for expenses.

In considering any statement of assets and liabilities, it should, therefore, be remembered that:

An asset increased means either
- Income earned;
- A liability incurred;
- Another asset decreased.

A liability increased means either
- An expense incurred;
- An asset increased;
- Another liability decreased.

Income earned means either
- An asset increased;
- A liability decreased.

An expense incurred means either
- An asset decreased;
- A liability increased.

It is accordingly evident that any increases or decreases of assets and liabilities which do not affect other asset and liability accounts, must apply to accounts for income and expense. This gives one of the best methods of guarding against errors in the accounts, such as are almost sure to occur if the volume of business is large. A careful checking of the balances of these various accounts to see that they agree with the actual facts which they are supposed to represent will often show items improperly omitted or improperly included in preparing the statements of income and expense.

A statement of assets and liabilities will present in general outline, the following facts:

ASSETS

Current Assets
- Representing cash, accounts receivable, product not yet paid for, inventories and such other assets as constitute the current working capital of the mine.

Deferred Charges
- Representing operating expenses to be charged against future, as distinguished from present, production.

Fixed Assets:
- Representing the net investment in property, construction and equipment (the property being carried on the basis of its cost and not at the value of its future production)

Making the total assets of the company

LIABILITIES

Current Liabilities:
- Representing the current indebtedness outstanding.

Fixed Liabilities:
- Representing bonded or mortgage indebtedness not requiring immediate payment.

Reserves:
- Representing an allowance made for future indebtedness or for the replacement or writing off of assets.

Making the total liabilities and reserves outstanding against the assets.

Capital Stock:
- Representing the par value of the full-paid capital stock outstanding.

Surplus:
- Representing the difference between the total assets and the total liabilities, reserves and capital stock. (The surplus must also represent the net results of profits from operation, or from other sources, less the dividend disbursements.)

Making a total on the liability side to equal the total of the assets.

In concluding such an outline, it may not be amiss to mention a few matters essential to a clear, consistent set of accounts and records:

RESUME OF MINE-ACCOUNT RECORDS.

(1) The original records should give the information on which all subsequent entries are to be based. Whatever divisions are to be made in the accounts should be considered in the original records. It is much easier to summarize items to get a total than to analyze an amount to obtain its details.

(2) The records should be so planned that the original entries can readily be referred to. Even the outside records kept in pencil can be arranged for proper files or binders. Each record should show clearly where its entries come from and any other records to which they go. Care in planning the records so that they will run in proper series will avoid a duplication of work and will make it much easier to trace individual items throughout the accounts.

(3) A clear and correct statement of the facts is the main object of the accounts. Undue formalities are neither necessary nor desirable. It is often better to make a clear record in statement form, rather than a debit and credit account The order in which facts and figures would naturally and logically be entered in the original record is usually the best to follow. There must be a certain amount of formal bookkeeping to give a ready proof that every item is fully accounted for, but this should summarize rather than duplicate the various operating statements.

There are many other features of the accounts which might be discussed at length, but the purpose of the above has been to present such an outline as might enable the operating men on the one side and the office men on the other to have a clearer conception of the general nature and meaning of accounting statements.

If the accounting force realizes clearly just what the various accounts and statements are intended to show, much cleaner and more accurate records will result. If the operating men can count on promptly receiving correct statements showing the facts with which they have to deal, presented in a manner which they can readily understand, there will be a practical value in the accounts far beyond their mere proof of the honesty of the employees and the amounts owing to or by the company.

Finally, the best test of a system of accounting is whether it gives promptly, clearly and simply the desired information with not unnecessary loss of time or labor in keeping the records, or making up statements therefrom.

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The foregoing article is reproduced particularly for the reason that its author comes from the house of Suffern & Son, New York, special auditors to the Utah Copper Company. As the reader will have noted, the subject is an important one and is well handled. The thing that will appeal to many of the readers of Mines and Methods is, that while this firm knows precisely how to elucidate a corporation status, they evidently are not averse to giving their patrons what they want; because, if there ever was in this world an incomprehensible compilation of utterly valueless figures, they are to be found in Suffern & Son's auditors' presentation of the affairs of the Utah Copper Company.

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Pumps often give trouble because of an unequal pressure within the steam-chest acting on the area of the steam valve or the valve stem. As the valve stem extends through only one side of the steam chest there is a constant tendency to blow it out. To overcome this trouble the use of a coil spring between the bracket and collar has been recommended. This spring should be given sufficient tension to counter balance the action of the steam acting on the area of the valve stem. While the action of the steam is to force the valve stem out of the chest, the spring forces it in again and therefore the forces are neutralized and the valve stem stays where it is left by the tappet arm.